Printed on Thin Paper for Foreign Circulation.

MAR 1 6 1923

The Engineer.

Established 1856.

Registered as a Newspaper.

OFFICE FOR ADVERTISEMENTS & PUBLICATION, 33, NORFOLK ST., STRAND, LONDON, W.C. 2.

VOL. CXXXV.—No. 3505] LONDON: FRIDAY EVENING, MARCH 2, 1923 [PRICE ONE SHILLING BY INLAND POST 1s. 3d.

PUBLIC NOTICES

Assistant Engineers REQUIRED for the Public Works Department of the Federated Malay States for four years' service, with prospect of permanency. Salary 400 dollars a month, rising to 880 dollars a month by annual increments of 25 dollars a month, plus a temporary non-pensionable allowance of 10 per cent. The exchange value of the dollar in sterling is at present fixed by the Government at 2s. 4d., but its purchasing power in Malaya is at present considerably less than that of 2s. 4d. in the United Kingdom. Free passage provided. Candidates, age 25 to 35, unmarried, must have received a good theoretical training, preferably at a University or Engineering College recognised by the Institution of Civil Engineers, or have completed articles with civil engineer of good standing and have passed the examination for associate membership of the Institution of Civil Engineers. Possession of an engineering or science degree preferred. Must have had at least two years' practical experience in the design and execution of works of some considerable magnitude. A knowledge of modern roadmaking and maintenance is desirable.—Apply at once by letter, giving brief details of qualifications and experience, to the CROWN AGENTS FOR THE COLONIES, 4, Millbank, Westminster, London, S.W. 1, quoting M/11,839. 1642

Royal Show.

NEWCASTLE-UPON-TYNE.
JULY 3rd to 7th, 1923.

EXHIBITION OF IMPLEMENTS, &c.
THE REGULATIONS AND FORMS OF APPLICATION FOR SPACE ARE NOW READY.
Applications must be made by
TUESDAY, 20th MARCH, 1923.

Live Stock entries close on MAY 1st; Poultry, Rabbits, Produce, Forestry and Horticultural Exhibitions on MAY 21st; Competitions for Plantations, Home Nurseries, Orchards and Fruit Plantations on MAY 1st.

T. B. TURNER, Secretary.
ROYAL AGRICULTURAL SOCIETY OF ENGLAND,
16, Bedford-square, London, W.C. 1.
January, 1923. 1661

Bombay, Baroda, and Central INDIA RAILWAY COMPANY.
The Directors are prepared to receive up to Noon on Wednesday, 14th March, TENDERS for the SUPPLY of—
CHEMICALLY DRESSED WAGON COVERS.
Tenders must be made on forms, copies of which, with specification, can be obtained at these offices on payment of 10s. each (which will not be returned).
The Directors do not bind themselves to accept the lowest or any Tender.

S. C. S. YOUNG,
Secretary.

Offices, 91, Petty France,
Westminster, S.W. 1.
26.2.23. 1656

Bombay, Baroda, and Central INDIA RAILWAY COMPANY.
The Directors are prepared to receive up to Noon on Friday, 23rd March, TENDERS for the SUPPLY of :—
1. LOCOMOTIVE ENGINES AND TENDERS.
2. SUPERSTRUCTURE FOR RENEWAL OF BASSEIN BRIDGES.
Tenders must be made on forms, copies of which, with specification, can be obtained at these offices on payment of 20s. each (which will not be returned).
The Directors do not bind themselves to accept the lowest or any Tender.

S. C. S. YOUNG,
Secretary.

Offices: 91, Petty France,
Westminster, S.W. 1.
28th February, 1923. 1717

CONTRACTS AND TENDERS.

Bombay Port Trust.
The Consulting Engineers and Agents are prepared to receive TENDERS for :—
(1) FIFTY OPEN GOODS WAGONS (Four-wheeled), complete, without Wheels and Axles.
(2) 100 PAIRS of WHEELS and AXLES.
Specifications and forms of Tender can be obtained at Dartmouth House, 2, Queen Anne's-gate, Westminster, London, S.W. 1, on or after 5th March, 1923.
A fee of £1 1s. will be charged for the specification, but will be returned on receipt of a bona fide Tender.
Tenders must be submitted not later than Noon on Friday, 23rd March, 1923.
The Trustees do not bind themselves to accept the lowest or any Tender. 1722

Corporation of Calcutta.
NOTICE TO CONTRACTORS.
TENDERS are INVITED for the SUPPLY, ERECTION and INSTALLATION of an AERIAL ROPEWAY for the removal of the city refuse from the site of the motor lorry platform at Chingrighatta to the Square Mile.
Tenders should be submitted in duplicate and should be enclosed in a sealed cover superscribed "Tenders for the Erection and Installation of an Aerial Ropeway," and should be addressed to the Deputy Chairman, Corporation of Calcutta, Central Municipal Office, 5, Corporation-street, Calcutta, and must reach him on or before the 30th April, 1923, when they will be opened in the presence of such tenderers or their accredited representatives as may be present.
Tenders must remain open for acceptance for at least three months from the date of opening.
For further particulars, if required, apply to the Chief Engineer, Corporation of Calcutta.
One set of the specification in duplicate with copies of plans may be obtained gratis from Messrs. The Indian and Eastern Engineer, 50, Fenchurch-street, London, E.C. 3.
The Corporation do not bind themselves to accept the lowest or any Tender.
JAMES R. COATS, B.Sc., M. Inst. C.E.,
Chief Engineer.
Central Municipal Office,
31st January 1923. 1573

The Engineer

PRINCIPAL CONTENTS OF THIS ISSUE.

February Engineering Notes.
Industries Fair at Birmingham—No. II.
New Means of Ascertaining Mean Pressure in a Heat Engine.
A New Electrical Research Laboratory.
Experiments in Superheated Steam.
A New Engine Indicator.
G.W.R. Express Running: Birmingham to Paddington.
Lathe Tool Research.

PUBLIC NOTICES

City of Manchester.
RIVERS DEPARTMENT.
The Rivers Committee invite TENDERS for the SUPPLY and DELIVERY to their Davyhulme Sewage Works, Urmston, of a SADDLE-TANK, 4-WHEELED COUPLED STEAM LOCOMOTIVE, 3ft. gauge, new or second-hand. An engine of superior type is required, capable of drawing on the level 230 tons (exclusive of its own weight) and 50 tons up a gradient of 1 in 50. In the case of a second-hand locomotive full particulars should be given as to cylinder dimension, stroke, wheel base, diameter of wheels, pressure insured to, maker, date built, and whether the locomotive may be inspected under steam. Parties tendering should give all the details asked for, with any other necessary particulars, including drawings or photographs of the locomotives offered.
Tenders should be addressed to the Chairman of the Rivers Committee, Town Hall, Manchester, superscribed "Tender for Locomotive," and should be delivered not later than Monday, the 12th March, 1923.
The Committee do not bind themselves to accept the lowest or any Tender.
By Order,
F. M. HEATH,
Town Clerk.
Town Hall, Manchester,
24th February, 1923. 1649

South Staffordshire Water- WORKS COMPANY.
PRESTWOOD BOREHOLES.
CONTRACT NO. 1.
TO BOREHOLE SINKERS.
The Chairman and Directors are prepared to receive TENDERS for SINKING LARGE BOREHOLES on the site of the Prestwood Pumping Station at Stourton, near Stourbridge, in the County of Stafford.
Copies of conditions of contract, specification, with form of Tender and schedule of quantities, may be obtained from the undersigned.
Sealed Tenders, addressed to me and endorsed "Tender for Boreholes," must be delivered not later than Noon, Thursday, the 15th March.
The Chairman and Directors do not bind themselves to accept the lowest or any Tender.
FRED. J. DIXON, M. Inst. C.E.,
Engineer.
Engineer's Office,
20a, Paradise-street, Birmingham,
February, 1923. 1615

State Electricity Commission OF VICTORIA.
TENDERS FOR PLANT.
TENDERS are hereby INVITED for the SUPPLY, DELIVERY, &c., of the following for the Morwell Power Scheme.
Copies of Tender form, specification, contract conditions and drawings may be obtained or inspected at the office of
The Agent-General for Victoria,
Melbourne-place, Strand,
London, W.C. 2.
SPECIFICATION No. 23/28.—WATER SCREENING PLANT.
Prospective tenderers without Australian representation should note that time does not permit of their detailed Tender being received at this office by date of closing of Tenders, and should therefore cable direct the following particulars :—
1. Price.
2. Delivery.
3. Particulars marked with an asterisk in the schedule of plant details.
4. Whether or not one set may be delivered before the complete plant, and, if so, at what date.
Detailed Tender, on prescribed form, should be posted by earliest possible mail.
The Commission does not bind itself to accept the lowest or any Tender.
R. LIDDELOW,
Secretary.
State Electricity Commission of Victoria,
1641 Melbourne, Australia.

PUBLIC NOTICES

The Great Indian Peninsula RAILWAY COMPANY.
The Directors are prepared to receive TENDERS for the SUPPLY of the following STORES, namely :—

No.		Fee for Specification.
1.	STATIONERY, &c.	10s.
2.	SPARE PARTS of CARRIAGES and WAGONS (W.I. Axle Guards, &c.)	£1
3.	HELICAL SPRINGS and VOLUTE SPRINGS	£1
4.	SPARE PARTS of CARRIAGES and WAGONS (Buffers, &c.)	£1
5.	LIGHT STEEL TROLLEY WHEELS and AXLES	7s. 6d.

Specifications and forms of Tender may be obtained at this office on payment of the fee for the specification, which payment will not be returned.
The fee should accompany any application by post. Cheques and postal orders should be crossed and made payable to the Great Indian Peninsula Railway Company.
Tenders must be delivered in separate envelopes, sealed and addressed to the undersigned, marked "Tender for Stationery, &c.," or as the case may be, not later than Eleven o'clock a.m. on Tuesday, the 13th March, 1923.
The Directors do not bind themselves to accept the lowest or any Tender.
R. H. WALPOLE,
Secretary.
Company's Offices :
48, Copthall-avenue, E.C. 2,
London, 28th February, 1923. 1716

Urban District Council of WINDLESHAM (SURREY).
NEW SEWERAGE AND SEWAGE DISPOSAL SCHEME FOR BAGSHOT, LIGHTWATER AND WINDLESHAM.
UNEMPLOYMENT RELIEF WORKS.
GENERAL CONTRACT.
The Urban District Council of Windlesham invite TENDERS from responsible and experienced contractors for the CONSTRUCTION of these WORKS, which comprise about 10 Miles of Stoneware and Cast Iron Sewers, Brick, Concrete and Cast Iron Manholes, Flushing Tanks, Ventilating Shafts and Columns, Cast Iron Rising Mains, Air Mains, Engines, Compressors, Ejectors, Ejector Stations, Engine-houses, Balancing, Detritus, Sedimentation, Upward Flow, Storm, Humus and other Tanks, Percolating Filters, Laying Out Storm Water Area, Roads, Paths, and other incidental Works.
A copy of the specification and form of Tender may be obtained on application, in writing, to Major T. J. Moss-Flower, Civil Engineer, 28, Victoria-street, Westminster, S.W., and Carlton Chambers, Bristol, at his Bristol office, on and after 5th March, 1923, on deposit of a £10 Bank of England note, which will be refunded provided a bona fide Tender be received and is not withdrawn before the sealing by the Council of one of the Tenders, and provided also that all documents supplied be returned to the Engineer. On production of a receipt for the deposit, persons tendering may inspect the plans at Bagshot on a day and at a time and place which will be communicated to them.
The contractor carrying out the work will be required to comply with the regulations of the Unemployment Grants Committee with regard to the employment of labour during the performance of the contract.
Sealed Tenders, endorsed "Tender for Bagshot, Lightwater and Windlesham Sewerage and Sewage Disposal Works, General Contract," are to be delivered at the Council Offices not later than Noon on 20th March, 1923.
The lowest or any Tender will not necessarily be accepted.
Dated this 24th day of February, 1923.
By Order,
EDWYN T. CLOSE,
Solicitor and Clerk to the Council.
Council Offices,
Bagshot (Surrey). 1664

PUBLIC NOTICES

Bombay Port Trust.
ENGINEERING ASSISTANT.
The Trustees of the Port of Bombay REQUIRE the SERVICES of an ENGINEERING ASSISTANT with good experience in Girder, Bridge, and Roof Steel Work Design, Building Construction, and Heavy Masonry Work. Should preferably have obtained experience in connection with railway or dock work and have been some time with a good contractor. Capable of preparing designs and drawings and making calculations under the direct supervision of an Executive Engineer. Salary Rupees 850 per month, rising annually by Rupees 30 per month to Rupees 940, and, if married, with such married officers' house allowance as he may be eligible for under the rules of the service. Three years' agreement.—Applications, in writing only, stating age, whether married or single, education, technical qualifications, &c., with copies of testimonials, to the CONSULTING ENGINEERS and AGENTS, Bombay Port Trust, 2, Queen Anne's-gate, Westminster, S.W. 1. 1663

County of London.
The London County Council invites APPLICATIONS for the POSITION of SUPERINTENDENT of Blackwall, Greenwich, and Rotherhithe Tunnels and Deptford Creek Bridge, at a salary commencing at £800 a year and rising by annual increments of £12 10s. to a maximum of £350 a year.
The foregoing salary is based on pre-war conditions and is at present subject to temporary additions on the Civil Service Scale, fluctuating according to the cost of living and making the total commencing remuneration at present about £441 a year. In addition, the Superintendent will be provided with house, light, and coal (valued for superannuation purposes at £80 a year) free.
Candidates must not be less than 30 nor more than 45 years of age on the latest date for receiving applications, and must have been trained as mechanical engineers or electricians and have a working knowledge of both trades.
Applications must be on the appropriate official form, which gives particulars of the duties and specifies the conditions on which the appointment will be held.
Forms may be obtained from the Clerk of the Council, the County Hall, Westminster Bridge, S.E. 1, and must be returned to the County Hall not later than 4 p.m. on Monday, 12th March, 1923. Applications for forms must be accompanied by a stamped addressed foolscap envelope.
Preference will be given to men who have served or attempted to serve with H.M. armed Forces. Canvassing disqualifies.
JAMES BIRD,
1710 Clerk of the London County Council.

Newmarket Rural District COUNCIL.
SOHAM WATERWORKS.
ENGINEER WANTED.
The above Council are prepared to receive APPLICATIONS for the APPOINTMENT of ENGINEER at their Waterworks at Soham, Cambs.
Candidates must be fully qualified to drive an oil engine and pumping machinery and to carry out all necessary repairs to mains, stand pipes, meters, and make connections, and must give their whole time to the duties.
Applications, stating age, qualifications, and salary required, and accompanied by copies of not more than three recent testimonials, must be sent to the undersigned, not later than Saturday, the 10th March next.
By Order,
S. J. ENNION, Major,
Clerk to the Council.
Dera Chambers, Newmarket,
27th February, 1923. 1706

South Indian Railway Com- PANY, LIMITED.
A DRAUGHTSMAN is REQUIRED by the above Railway, to Take Charge of the Chief Engineer's Drawing-office in India. Applicants, who should be between the ages of 25 and 35 years, should have held a responsible position in a consulting or civil engineer's office, have been engaged upon the plans and execution of new works, and have a good knowledge of general drawing-office routine.
Salary will commence at date of leaving England, at the rate of Rupees 450 per month, rising by yearly increments of Rs. 50 per month to Rs. 800 per month. Agreement in the first instance is for three years and passage to India and home again on termination of appointment will be paid by the Company.
Applications, stating age, education, training, experience, and qualifications, should be addressed to Messrs. Robert White and Partners, the Company's Consulting Engineers, 3, Victoria-street, London, S.W. 1.
A. MUIRHEAD,
Managing Director.
91, Petty France, S.W. 1.
26th February, 1923. 1670

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SITUATIONS WANTED, Page 2.
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For Advertisement Rates See Page 233, Col. 1.

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SITUATIONS OPEN

WANTED, for London Area, YOUNG ENGINEER as TRAVELLER by Firm specialising in High-speed Steam Engines, Boilers, Gas Engines, &c. State age, particulars of training and experience; salary required.—Address, 1686, The Engineer Office. 1686 A

WANTED, WORKS SUPERINTENDENT, to Take full Charge of Small Works, London district, consisting of machine and fitting shops and foundry. Must be technically trained and have design and drawing-office experience, and fully capable of taking entire charge. None need apply without above experience. Commencing salary £500 per annum.—Address, stating age, experience, and when able to commence, 1692, The Engineer Office. 1692 A

A CITY ENGINEER REQUIRES the ASSISTANCE for several months of a thoroughly competent STEEL and R/F CONCRETE DESIGNER and DRAUGHTSMAN for the purposes of a large Electric Generating Station.—Address, 1708, The Engineer Office, stating experience, salary required, when disengaged, &c. Send no original testimonials. 1708 A

A LARGE MANUFACTURING FIRM in England REQUIRES the ASSISTANCE of an ENGINEER with general experience in the design, construction, and the practical operation in service of Electric Locomotives.—Address, stating experience and salary required, 1668, The Engineer Office. 1668 A

A LEADING FIRM is Prepared to ARTICLE in the Patent and Trade Mark Agency Profession a well-educated YOUTH, 18 to 19 years of age, who has matriculated, and who is of scientific bent and training. Services would be expected in return for articles (six years). Nominal salary after first year.—Address, P6997, The Engineer Office. P6997 A

ASSISTANT MECHANICAL ENGINEER WANTED, with knowledge of Constructional and Building Work, for London; A.M.I.C.E. preferred.—Write, with all particulars of qualifications, former experience, and salary required, to Z. J. 855, care Deacon's, Leadenhall-street, London. 1709 A

COMPETENT SALVAGE ENGINEER REQUIRED by large Shipbreaking and Salvage Company.—Address, P7002, The Engineer Office. P7002 A

ENGINEER SALESMAN.—An English FIRM in India REQUIRE an ENGINEER SALESMAN, to sell Machinery and Engineers' Tools, Steel Sections, &c., for which they have agencies. He must be accustomed to interviewing purchasers, obtaining orders, and travelling when necessary. Age 25 to 30 and a bachelor.—Write, stating experience and qualifications, to Z. L. 815, care Deacon's, Leadenhall-street, E.C. 3. 1662 A

EXPERIENCED SALES ENGINEER for Electrical Hoisting Machinery, Lifting Magnets, &c. Give fullest particulars. Required to commence duties at once. Works situated in the Midlands.—Address, 1667, The Engineer Office. 1667 A

GEAR EXPERT.—An Important FIRM of MOTOR CAR ENGINEERS near London is REQUIRING the SERVICES of a GEAR EXPERT. Applicants must be thoroughly experienced on all points in connection with the cutting and quietening of gears of all types and qualified to deal with all matters in connection with same in an advisory and executive capacity. Full details of experience (stating firms), age, and salary required should be sent.—Address, 1712, The Engineer Office. 1712 A

MAN to TAKE CHARGE of the ASSEMBLY and REPAIR of a variety of ELECTRICAL TEMPERATURE MEASURING INSTRUMENTS. Must be a good organiser and have had some years of works experience. Give full particulars of both theoretical knowledge and work previously engaged on, stating approx. salary expected.—Address, 1685, The Engineer Office. 1685 A

REQUIRED by Large Continental Manufacturers of High-grade Steels, CORRESPONDENCE CLERK for Head Office on the Continent.—Address, stating fullest particulars of experience, salary required, age, &c., 1699, The Engineer Office. 1699 A

REQUIRED for Branch of Large Agricultural Implement and Engineering Concern in South of England, competent MAN to Take Charge, Attend Markets, and Superintend all Repairs.—Address, with particulars of age, salary required, and past experience, 1695, The Engineer Office. 1695 A

SUPERINTENDENT REQUIRED for Engine Department of Large Engineering Works in Midlands; experience in economical production of Crude Oil Engines of the Semi-Diesel and Cold Starting Types essential. State age, experience, and salary required.—Address, 1654, The Engineer Office. 1654 A

TECHNICAL ASSISTANT to CHIEF ENGINEER REQUIRED. Must be man with first-class practical and commercial experience and used to maintenance work.—Write, stating fully qualifications, age, and salary required, Box 1404, Bell's Advertising Offices, Fleet-street, E.C. 4. 1671 A

TEST ROOM.—ASSISTANT MANAGER REQUIRED for Test Room of Large Electrical Manufacturing Company. Must be fully acquainted with the Testing, Inspecting and Adjusting of Large D.C. and A.C. Motors and Generators, also Turbo-generators of larger sizes. Only people with over six years' experience in test room considered.—Address, giving full particulars of past services, education, and salary expected, 1654, The Engineer Office. 1654 A

WATER INSPECTOR.—A Thoroughly Experienced and efficient WATER INSPECTOR for locating leaks.—Address application, stating qualifications, to the SURVEYOR, Town Offices, Littlehampton. P7003 A

WANTED, a First-class DRAUGHTSMAN, with experience in the Design of Woodworking Machinery.—Write, stating age, salary, and experience, Box 2500, Willing's, 30, King-street, Covent Garden, W.C. 2. 1704 A

WANTED, DRAUGHTSMAN, Fully Qualified general engineering, with long experience of Hydraulic Machinery. State experience, age, salary required, &c.—Address, 1715, The Engineer Office. 1715 A

WANTED IMMEDIATELY in Westminster, JUNIOR DRAUGHTSMAN, accustomed to Steel Structural Engineering; excellent opportunity gaining experience. State age and other details and when at liberty.—Address, 1718, The Engineer Office. 1718 A

WANTED, Young DRAUGHTSMAN, Single, in Engineering Department; must be capable of Calculating Stresses and Strains of Metals. Practical engineering experience not essential.—Address, stating age and salary required, 1707, The Engineer Office. 1707 A

DRAUGHTSMAN WANTED AT ONCE; Must be capable and experienced in Design of Chain and Travelling Grate Mechanical Stokers. Give details of experience and state salary required.—Address, P7019, The Engineer Office. P7019 A

DRAUGHTSMAN WANTED by Important Firm in Midlands. Must have wide experience in Steam Engines and Pumping Machinery. Progressive salary to suitable man.—Address, stating age, experience, and salary required, 1711, The Engineer Office. 1711 A

DRAUGHTSMAN WANTED for East Midlands; experienced in the design of up-to-date Enclosed Forced Lubrication High-speed Vertical Engines and large size Vertical Air Compressors. State age, experience, and salary required. Only those with every necessary qualification need apply.—Write, Box 1414, Bell's Advertising Offices, Fleet-street, E.C. 4. 1721 A

SITUATIONS OPEN (continued)

DRAUGHTSMAN WANTED. Fully Experienced in Railway Carriage and Wagon Work. Experience in Steel Coach Design an advantage.—Apply by letter only, stating age, experience, and salary required, to Chief Draughtsman, LEEDS FORGE CO., Ltd., Carriage Works, Newlay, Leeds. 1648 A

DRAUGHTSMAN WANTED; Experience in Design Crushing and Cement Machinery.—Write, giving full particulars, experience, age, and salary required, to "W. J. C.," Engineering Department, Edgar Allen and Co., Ltd., Imperial Steel Works, Sheffield. 1648 A

DRAUGHTSMEN WANTED, Thoroughly Experienced in the design of:—
(a) Heavy Steel Bridges, both fixed and movable.
(b) Steel Caissons and Gates for Dock Entrances.
(c) General Dock and Railway Construction Work.
Only men of the highest abilities in design and detailing of such work need apply.
Applications, stating age, salary required, and full particulars of training and experience and when at liberty, to be addressed to Box No. 2458, Willing's, 30, King-street, Covent Garden, W.C. 2. 1598 A

DRAUGHTSMAN WANTED, with Experience in Steam Turbine Work, preferably of the Impulse Type.—Apply, stating experience in detail, age, whether married or single, wages required, and when at liberty, to W. H. ALLEN, SONS and CO., Ltd., Bedford. 1694 A

ENGINEERING DRAUGHTSMEN REQUIRED; Aircraft experience preferred, but not essential.—Reply, stating age, experience, and salary required, to Box 297, T. B. Browne's Advertising Offices, 163, Queen Victoria-street, E.C. 4. 1604 A

EXPERIENCED DRAUGHTSMAN REQUIRED, with knowledge of Design of Steam Navvies and Diggers. Advertisers are well-known engineers in Yorkshire. Give full particulars of experience, age, and salary.—Address, 1688, The Engineer Office. 1688 A

GOOD MECHANICAL ENGINEERING DRAUGHTSMAN REQUIRED, with Centrifugal Pump Design Experience preferred, for Midland firm. State age, wage, and experience.—Address, 1691, The Engineer Office. 1691 A

LOCOMOTIVE DRAUGHTSMAN, Manchester District, for the Design of Mechanical Parts of Electric Locomotives. Electrical experience not necessary. State age, experience, and salary.—Address, 1665, The Engineer Office. 1665 A

REQUIRED, Westminster Office, MECHANICAL DRAUGHTSMAN (age 25-30). Only those with Locomotive and General Engineering Experience need apply.—Address, giving full details of shop training, technical education, experience, age, &c., and salary required, P7010, The Engineer Office. P7010 A

TRACER, First-class, WANTED, Engineering Works, 30 miles from London. Age, full particulars of experience and salary required.—Address, 1666, The Engineer Office. 1666 A

ENGINEER WORKING FOREMAN WANTED for provincial shop; about 30 hands. State age, experience, salary, when commence. Copies references only (not returnable).—Address, 1586, The Engineer Office. 1586 A

FOREMAN REQUIRED for Fitting and Erection Shop in works producing Semi-Diesel Oil Engines. Applications only considered from men having extensive experience on this class of work. State age, experience, and salary required.—Address, 1655, The Engineer Office. 1655 A

REQUIRED by a European Firm of Structural and General Engineers in India, an ASSISTANT FOREMAN in their Structural Department. Applicants must have experience in Template Making and be accustomed to Bridge, Roof and General structural Work. Must be a bachelor and not more than 26 years of age.—Apply, stating age and full particulars of experience, to Z. Y. 824, c/o Deacon's, Leadenhall-street, London. 1676 A

PATTERNMAKER WANTED, First-class Man; must be used to Loam Work; London district.—Address, 1698, The Engineer Office. 1698 A

RATE FIXERS REQUIRED by Engineering Works in the Midlands. Previous rate fixing experience absolutely essential.—Address, stating age, experience, and salary required, 1714, The Engineer Office. 1714 A

ESTIMATING CLERK REQUIRED for Large Railway Carriage and Wagon Works in the North.—Address, stating age, experience, and salary required, 1701, The Engineer Office. 1701 A

SITUATIONS WANTED

BUYER.—The MANAGER of a Large Engineering Works Purchasing Dept., who has an exceptionally wide knowledge of the markets of the country, DESIRES to NEGOTIATE NEW APPOINTMENT.—Write, Z. M., 815, c/o Deacon's, Leadenhall-street, E.C. 1626 B

CAMBRIDGE GRADUATE (Hons. Degree Engineering, 1922) DESIRES POST either in works or attached to civil engineer with view to obtaining experience. Preferably with prospect of being taken on later if approved. Excellent testimonials.—S., 15, Cumpergate, Peterborough. P7007 B

CHIEF ENGINEER of IMPORTANT COMPANY DESIRES CHANGE.
Minimum salary £1000.
Address, P7026, The Engineer Office. P7026 B

CIVIL ENGINEER, B.Sc., Experience with Government and contractors on irrigation projects, masonry works, weirs, dams, surveys, presently OPEN for ENGAGEMENT.—Address, P7015, The Engineer Office. P7015 B

CIVIL ENGINEER, Who Can Invest up to £1500, SEEKS ACTIVE PARTNERSHIP or EMPLOYMENT on commission basis in any genuine concern where below-mentioned experience may be usefully employed.
Training in workshops and drawing-office of engineers and contractors; short term in consulting engineer's office; many years' experience on maintenance and construction of railways in difficult country abroad, holding important administrative engineering posts; Assoc. M. Inst. C.E.; fluent Spanish and considerable French.
Scope for experience, energy, and originality more important than immediate high remuneration.—Address, P7000, The Engineer Office. P7000 B

ENGINEER, B.Sc. (Lond.), Assoc. M. Inst. C.E., A.C.G.I., formerly on staff of leading railway, now with constructional firm, DESIRES CHANGE with prospects. Fifteen years' experience all classes structural work. Entire responsibility, used control staff.—Address, P7004, The Engineer Office. P7004 B

ENGINEER, Mechanical and Electrical, DESIRES POST, Works Engineer. Sound shop and D.O. experience, gas, chemical, steam, &c., works maintenance and erection. At liberty near future.—Address, P7025, The Engineer Office. P7025 B

ENGINEER, Mechanical, Experience as Manager of general engineering works, foundry, boiler-making, accustomed to control staff and shops, DESIRES similar ENGAGEMENT; age 42.—Address, P6968, The Engineer Office. P6968 B

ENGINEER, M.I. Mech. E., M.I.N.A., Long Experience in engineering and refrigeration, technical and business sides, DESIRES PARTNERSHIP in good firm, or responsible POST; willing to travel.—Address, P6998, The Engineer Office. P6998 B

SITUATIONS WANTED (continued)

ENGINEER, 15 Years in Charge of Steam, Gas, electric plant abroad, SEEKS similar POSITION or ASSISTANT; age 38; speaks Spanish.—Address, P7062, The Engineer Office. P7062 B

ENGINEER (22), 6 Years Shops, 1 Year Technical College, sound commercial training, costing and bookkeeping, DESIRES POST as Assistant to Estimator, Cost Accountant, or in works staff.—Address, P7023, The Engineer Office. P7023 B

ENGINEER, 26 Years, First Class B.O.T. Certificate, DESIRES POST ashore; excellent references.—Address, P7030, The Engineer Office. P7030 B

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For continuation of Small Advertisements see page 3

FEBRUARY.

A Gift to Research.

IT was announced a few days ago that Sir Alfred Yarrow had presented to the Royal Society the great sum of one hundred thousand pounds for the furtherance of research. The terms of this magnificent gift—if terms they may be called—are remarkable. The donor leaves the Royal Society a free hand to do what it will with the money, and does not even limit it to the expenditure of the interest, because, as he says in a letter to the President, he recognises that "conditions alter so materially from time to time that, in order to secure the greatest possible benefit from such a fund, it must be administered with unfettered discretion by the best people from time to time available." He assumes that the Royal Society would appoint a committee to administer the fund, and would frame rules to guide that committee, and he suggests that the rules should come up for revision every tenth year, "so as to meet modern needs." He expresses a wish that the money should not be spent on costly buildings, but, lest anyone should regard his wishes as binding, he hastens to add that he does not intend "to create any trust or legal obligation for their fulfilment." In other words, he trusts the Royal Society to administer the gift from year to year, as long as it remains in existence, for the furtherance of the research of the day, in whatever manner seems best to it.

East Coast Express in Fatal Collision.

As the night express from Aberdeen and Glasgow to King's Cross was approaching Retford Station on the morning of the 13th of the month, it ran into a goods train, from which a wagon was being detached. No passengers met with any serious injury, but the driver, fireman and an inspector riding on the footplate were killed, and there was considerable damage to rolling stock. Owing to the goods train occupying the main line at Retford North box, the signalman had not sent the train-out-of-section block signal to Babworth, and the man in that box refused the express when it was offered him by Canal box. The signals at all the boxes were therefore at "danger," but the train passed them at full speed. The explanation is possibly to be found in the fact that there were patches of fog, but the fog-signalmen were not out. The driver, if he could not see the signals, would therefore get no warning, and as, in a fog, a "clear" signal is accompanied by the absence of the explosion of a detonator, the unfortunate man would have ground for assuming that the signals were "off." Colonel Pringle held his inquiry on the 16th, and we shall await his report with interest. It is safe to anticipate that it will point out that had automatic train control been in use, the driver would have been warned at Canal box distant that the home signal he was approaching was "on," and had he failed to respect the warning he would automatically have been pulled up.

French Trade Crisis.

So long as France was procuring some reparations from Germany, and was hopeful of obtaining still more, the industrial situation across the Channel was relatively satisfactory, for all the engineering and other firms had work in hand, and there was a steady improvement in the foreign trade in metallurgical products. The only thing needed to bring about a general revival was a little more financial stability. The whole of this promising outlook collapsed during the month as the result of the total cessation of coke supplies, and the consequent damping down of nearly all the blast-furnaces. As the iron and steel production is at a very low ebb, and no money can be found for industrial enterprise of any kind, the situation is a serious one, and as the country is practically living on stocks, it is hardly possible even to obtain prices. The depreciation of the franc has been accompanied by so considerable an increase in production costs that, pending the present economic crisis, they will be found relatively higher than British costs, which means that despite the exchange rate British firms are often able to turn out goods more economically than other countries. Even during January the trade returns showed a heavy falling off in exports, and the past month has seen a collapse of exportations, while the purchases abroad have probably largely increased. The French recognise the seriousness of the situation, but they are determined to "sit tight" until the reorganisation of the Ruhr shall have been completed, when it is hoped that the iron and steel industries will have everything necessary for their development; but if these expectations should fail to be realised, it is difficult to see how a way can be found out of the present troubles.

British Industries Fair.

THE British Industries Fair closes to-day, March 2nd, after being open since February 19th, concurrently at Birmingham and Shepherd's Bush. It was, of course, with the former section that engineers were chiefly concerned, as there were few, if any, exhibits of an engineering nature at the White City, while Birmingham is naturally a good centre for a show of machinery and hardware. The conditions under which the Fair is held, at Castle Bromwich Aerodrome, some miles out of Birmingham, are not, however, altogether ideal, and the discomfort of travelling to and fro in overcrowded trains may account to some extent for the rather poor attendance. Then, again, the weather was decidedly inclement on many days while the Fair was open. The stands presented much the same appearance as they did a year ago, and while a few of the familiar exhibitors were absent, the majority had again taken space in the buildings. It really seems a pity that the Fair is not more enthusiastically supported, both by our manufacturers and their possible customers, as there are few occasions when such opportunities are offered for an exchange of ideas and the careful inspection of the products of works scattered all over the country, without the distraction of uninterested casual visitors. We, ourselves, found the Fair an opportunity for renewing many friendships and making new ones, which would otherwise have entailed a great amount of travelling, while there is no doubt that many of the visitors found, as we did, subjects of deep interest, either on the stands themselves or in the conversation of the exhibitors, which would possibly have been overlooked in the rush of a tour round a factory. Anyhow, there was at least one novelty in the organisation of the Fair which appealed strongly to the exhibitors, and incidentally provided one of the daily incidents of the fortnight. That was the arrival of the aeroplane coming from Manchester and its subsequent departure for London. The service was obviously a great convenience to those exhibitors who had stands at the two branches of the Fair, and provided a rapid means of transport at a cost which compared very favourably with that by railway. Taking all things into consideration, the Fair this year cannot be said to have been a failure, neither can it be described as a great success. Perhaps the decision to hold the Fair in the spring of next year may give new impetus to an institution that has every appearance of "fizzling out," regardless of its many excellent qualities, if it is continued on the present lines.

Manchester Ship Canal.

As an example of what can be achieved by patience, determination and good management, the Manchester Ship Canal is an unique instance in this class of undertaking. The shareholders in this company have every reason to be satisfied with the annual report on the past year's operations, which was published during the month. It is all the more satisfactory in that trade generally, and Lancashire export trade in particular, was during last year probably at its lowest ebb. In spite of these adverse conditions, the concern has yielded a profit which not many years ago would have been regarded as quite impossible. The sea-borne traffic dealt with during the year showed a very distinct advance upon that handled during 1921. No less than 4,081,571 tons were dealt with, compared with 3,117,469 tons. The receipts showed a corresponding increase, and amounted to £1,332,490, which amount was earned with a reduction in expenditure of no less than £78,528. Having now placed this great inland waterway upon a successful commercial basis, the directors can look back with equanimity upon the early struggles for a bare existence which the Canal experienced.

The Railway Results.

THE first of the principal English railways to declare its dividend for last year was the Great Northern. It is paying on its ordinary shares 6 per cent. for the year, as against 4½ per cent. a year ago, and 7 per cent. on the deferred ordinary, as compared with 2½ per cent. The announcement created great surprise generally, and many conjectures were made as to how this improvement had been made possible. Our impression at the time was that it was due to increased traffic, and we were led to that conclusion by the fact that at the Great Northern meeting a year ago Sir Frederick Banbury stated that the net receipts for the 4¼ months of decontrol in 1921 were £559,009—information that was not vouchsafed by any other chairman. When the Great Northern report was issued three weeks ago, it was seen that our conjecture was correct, and that the receipts for 1922 exceeded the expenditure by £2,530,047—a result only exceeded by the London and North-Western (£8,978,717), Great Western (£7,420,439), Midland (£5,749,407), and North-Eastern (£4,033,956). The declarations by the other principal companies were all of a gratifying character, but it was necessary for the Great Eastern, North-Eastern and North Staffordshire to take some of the compensation awarded by the Railways Act in order to equal the dividend for 1921. The annual meetings held during the month, except those of the Great Western (which retains its identity) and of the London electrically operated lines (which are not grouped), were the last held by the individual companies, and, owing to the satisfactory results of the year's working, were all of a happy character. In view of the increased dividends, the companies no longer can refuse to consider the question of a further reduction in rates. The London and North-Western and Midland reports intimated that this matter would receive attention.

Communist Strikes.

THE industrial difficulties the French have to contend against at the present moment were seized upon during the month by the Communist federations as a pretext for organising a general strike in the coal trades, and thereby completing the disorganisation of industry throughout the country. The moment was well chosen to demonstrate the power of Communism, if it possessed any power at all, and as the country is practically deprived of foreign coal for the time being, the revolutionary section hoped that a complete cessation of home supplies would render them masters of the situation. In some colliery districts, particularly in the Loire, the Communist spirit is so strong and aggressive that the declaration of the strike was regarded with some misgiving. The result, however, showed that, amongst the men, Communism succumbs to the national spirit in times of emergency, and while on the first day of the strike about 20 per cent. of the miners ceased work, they afterwards returned in such large numbers that in less than four days the strike utterly collapsed. This is the greatest defeat Communism has ever experienced in France. It clearly proves that it has no solid backing, even amongst men who in ordinary times are the most active in creating strife, and it offers further proof of the determination of the French to make the best of the situation until they are able to put things in order and get back to a normal state of industrial and financial activity.

Two Railway Accident Reports.

DURING the month three reports on railway accidents were issued, one of which was on the Birkenhead Park collision, which is the subject of a separate Note. The first report to appear related to a mishap on November 16th to a goods train, drawn by two engines, between Pinmore and Pinwherry stations on the Glasgow and South-Western. From a tunnel 1200 yards north of Pinmore Station the line falls towards the south—the direction taken by the train—at inclinations of from 1 in 92 to 1 in 80. After passing through Pinmore the fall is from 1 in 86 to 1 in 65. For reasons we need not explain, the brake was applied by the train engine, when approaching Pinmore, and then released. This action broke the coupling between the two engines, and the train automatically came to a stand. On restarting, a coupling broke between two wagons, but this failure was not discovered until the train was approaching Pinwherry. The train had to stop there, and when the driver of the train engine applied the vacuum brake he found it more effective than he expected. Looking back, he realised what had happened. He whistled to the pilot driver, and both men opened their regulators to get ahead, but owing to the sudden application of steam the train engine apparently primed badly with the result that water choked the ejector, rendering it inoperative or partly so. Water was afterwards found in the brake pipe when the engines were uncoupled. The engines could not therefore escape from the runaway wagons and a collision occurred, nineteen out of the twenty-eight wagons on the train being completely destroyed. The second report was on the collision of December 18th, near Stratford Market, Great Eastern Railway, when one of that company's passenger trains passed the starting signal at Abbey Gates signal-box on the North Woolwich branch, and ran into a London and North-Western goods train. The view of the starting signal is not a good

one, and it was necessary for the driver to cross the footplate to see it. When his regular fireman was with him, the driver relied on him to see the signal. On this occasion it was not his regular fireman; yet he did not cross the footplate.

Progress of Industrialism.

WHILE most other branches of industrial activity in France are practically arrested by the partial collapse of the iron and steel trades, the carrying out of electrification schemes continues to make headway, and a significant move during the month was the enterprising action of certain groups of power users which are circularising makers of pumps and machinery generally with a view of standardising types for use with electric motors. In the case of pumps, for example, these groups have come to the conclusion that agriculturists and others employing them for irrigation and water raising generally have every interest in selecting certain makes and holding stocks of spare parts, so that users will have facilities for keeping their pumps in good running order. Makers are therefore invited to offer pumps fulfilling certain definite requirements and to undertake to keep ample supplies of spare parts in the particular districts. There has been plenty of evidence lately to show that the national electrification scheme is favourable to a more general extension of machinery of all kinds. The country, being mainly agricultural, is suffering from labour scarcity, and wages are increasing so rapidly that machinery is more in request than ever before; and now that cheap electrical energy is being distributed the agricultural industry is coming more and more within the domain of practical engineering. In the same way, all the small industries are being transformed by the economies which are promised by means of the new electrical distribution, and the interest being shown in everything capable of realising some economy points to an active demand in the future for labour-saving machinery.

The Ruhr Problem.

THE work of railway and industrial organisation carried out in the Ruhr during the month proves that the French have no intention of relinquishing that territory until they have secured all the guarantees necessary for the payment of reparations. The results obtained are so inadequate, in view of the importance of the machinery set in motion, that it would appear difficult to justify the occupation if it were not for the underlying motives of a purely economic character, which make it impossible for the French to draw back. One object of the organisation is to obtain from the Ruhr the coke necessary for the smelting of Lorraine iron ores. Since the recovery of Lorraine, with its estimated total of 5000 to 6000 million tons of phosphoric ore, France should be able to produce and smelt 43 million tons of mineral a year, on condition of procuring the 18 million tonso f coke required. Even under the most favourable conditions, more than two-thirds of this quantity would have to be imported. As the Ruhr coal basin, which alone produces blast-furnace coke of good quality, is separated from the Lorraine iron ore district, it was naturally suggested that there should be an interchange of iron ore and coke. The French refuse to entertain such a proposal until the whole question of reparation is settled, and, in any case, their policy is to lay hands on the entire coke production of the Ruhr, which will enable them to bring Germany to terms, and at the same time provide France with the only thing lacking for a very considerable development of the iron and steel trades. It is feared that the struggle will be carried out to the bitter end, merely because the issues are vital, and so long as the Lorraine industry is dependent upon Ruhr coke there will always be germs of future trouble.

The Third Air Conference.

THE third Air Conference organised by the Air Ministry was held at Guildhall on Tuesday and Wednesday, the 6th and 7th of the month, the first day being devoted, as usual, to the reading of papers and the second to their discussion. Reviewing the present position of air transport, Sir W. S. Brancker reported an improvement in the safety and trustworthiness of civil aviation, but could record only a small increase in the number of passengers being carried. With sufficient traffic, he said, the cross-Channel services could be made self-supporting, but to-day the passengers carried were numerous enough only to keep a fleet of three single-engined aeroplanes in full employment. He believed that in a few years' time it would be possible to carry ten passengers at 100 miles an hour for about 2s. per mile, as compared with about 4s. 6d. at present. Commander Burney dealt with his scheme for the establishment of a self-supporting airship service, Mr. Fairey discussed seaplanes, and Colonel Ogilvie contributed a paper on gliders and their value to aeronautical progress. Sir W. G. Salmond, in his report on the progress of aeronautical research and experiment, dealt with many points of detail in which promising developments are in sight. In particular, he referred to the progress being made in connection with the heavy oil fuel aero-engine, a type of prime mover which for aeronautical purposes should lead to great economy of running expenses and simplification of the mechanical equipment. At the Royal Aircraft Establishment, a single cylinder of aero-engine type had, he stated, been run at 1000 revolutions per minute, and had given a mean effective pressure of 112 lb. per square inch for a fuel consumption of 0.415 lb. per brake horse-power-hour. Towards the attainment of low landing speeds, progress was recorded in several directions, and in the matter of metal propellers with detachable and variable pitch blades, a stage, it was reported, had been reached for which it might be claimed that the difficulties remaining were commercial rather than technical.

The Biskra Glides.

THE trials of gliders carried out during the month at Biskra, on the border of the desert to the south of Algeria, have merely confirmed results obtained at previous tests, without showing progress, or proving, indeed, that any further practical developments are possible in the present stage of the art of gliding. Apparatus remained in the air for hours on end, until the pilots were obliged to land, either through fatigue or on account of the darkness; but they could only start from a height and manœuvre within a limited area, according to the vagaries of the wind currents, and all efforts at making long straight flights failed. It is true that one competitor succeeded in gliding for a distance of about 5 kiloms. in a line, but it is pointed out that that could have been done by any aeroplane with the engine stopped. So much was expected from the Biskra trials that the somewhat poor results have disappointed French experts, who are of the opinion that until the glider is able to move from one point to another without depending upon air pressure under a falling momentum, no practical progress can be anticipated. It is not likely that much more official encouragement will be given to glider experiments in France until someone is able to show that an apparatus can be manœuvred consistently at altitudes above the starting level and in a more or less straight line.

The Birkenhead Park Collision.

THE report of Lieut.-Colonel Mount on the collision of December 12th at Birkenhead Park was issued on the 15th of the month. Both the trains concerned in the accident belonged to the Wirral Railway, but the station is owned jointly by the Wirral and Mersey companies. A passenger was killed, and this was the first fatality to a passenger in a train accident on either line. There are two island platforms at this station, but only that on the north, or river, side is used regularly. No. 1 road, the most northerly, takes the Mersey trains, and No. 2 takes the Wirral trains. The former are electrically and the latter steam worked, and each company's trains use Birkenhead Park as a terminus. No. 3 road is on the north side of the other island platform, and used for the Wirral engines to run round their trains. On the day in question the Wirral train, due to leave at 4.18 p.m., was late and it had not left when the train, due to arrive at 4.25 and to occupy the same platform, was "offered." As the line was clear up to the outer home signal, the signalman was allowed, under an exemption to block working allowed by the Ministry of Transport, to accept the arriving train. The distant signal was fastened in the "on" position, and did not therefore afford any warning to the driver that the outer home signal was at "danger." This man maintained that the latter signal was "off," and that, owing to steam, he could not see the inner home signal when passing through the intervening tunnel. The result was that the arriving train caught the outgoing train broadside at the crossover road leading from No. 2 platform to the down line. The driver was sixty-eight years of age, had been a driver for forty-four years, and had an excellent record in every respect. His fireman, though, was filling the lubricator—against the driver's wish—when approaching the station, and thus broke Rules 139 and 147 (*a*), and whilst the guard saw the other home signals at "danger," he did not apply the brake to stop the train.

Great Western Express Running: Birmingham—Paddington.

THE Great Western Railway's short route of 110¼ miles between Birmingham and Paddington is not only the most difficult of its main lines in respect of gradients, speed restrictions, and high average speed required, but its express service provides some of the most creditable locomotive work in this country.

The up two-hour expresses stop at Leamington, 23¼ miles from Birmingham, for which distance 26 min. are allowed. The remaining 87¼ miles are timed to be covered in 91 min., giving an average speed of 57.5 miles an hour over a hard road which includes three speed reductions for curves.

Going south from Snow Hill Station, trains have an easy start of 1 in 45 down for nearly a quarter of a mile, followed by a broken rise to Solihull, mostly at 1 in 550, 1 in 316, and 1 in 225, with moderate intervening gradients, and with heavy trains it is good work to pass Solihull, 6¾ miles, in 9¼ min. For 3¼ miles onwards the line is almost level, the next three falling at 1 in 273, followed by a short rise of 1 in 169 to Hatton, which should be passed in not more than 19¾ min. in order to effect a punctual arrival on a 20 min. schedule. The remaining 6 miles to the stop are easy—three falling at 1 in 104, on which brakes are usually applied.

Table A gives details of running over this section. The trains concerned are the 12.5 p.m., and the 2.50 p.m.—now 2.55 p.m.—before the stop at Banbury was made. These trains are worked by a 4–6–0 locomotive, usually of the four-cylinder class, though formerly the two-cylinder engines took their turn. The design is shown by the initial figure of the engine's number.

SNOW HILL TO LEAMINGTON.

It is not intended to describe each run. Those in Table A are arranged roughly on a time-keeping basis. Thus on the first three runs with their respective loads the drivers just kept within scheduled time, taking the usual 9¼ min. to Solihull and 10 min. for the next 10¼ miles to Hatton. At no point on these three runs did the comparative times vary more than 9 sec. In run 3 with 346 tons speed rose to 52 at Solihull—a satisfactory average at this point—increased to 58 on the level to Knowle, with a maximum of 68 before Hatton. Brakes were applied down Hatton bank, where the rate varied from 62 to 66.

The next three runs—4 to 6—show sound work with heavy loads of about 380 tons. No. 2937 ran well throughout. After a slight check the engine maintained a rate of 46.7 after Tyseley, passed Solihull at 52.9, and accelerated to 63.1 on the level, the next 6 miles being run at an average speed of 69.1 without exceeding a rate of 72. The 10¼ miles to Hatton were covered in 9 min. 26 sec.

By far the fastest run was made by No. 2926 with 315 tons in run 7. The first mile took 2 min. 7 sec., and the rise after Tyseley was ascended at a rate of 52.1. The first 5 miles occupied only 7 min. 11 sec., and Solihull was passed at the unusual speed of 60 in 9 min. 5 sec., the quickest start in the series. On the level to Knowle speed rose to 69.2, after which successive miles were run at speeds of 73.4, 75, 78.3, 80, 78.3, 75, 72. The 10¼ miles after Solihull took only 8 min. 27 sec., equal to an average speed of 72.7, which brought us through Hatton, 17¼ miles in 17¼ min., the best time to this point. Down the bank speed was not allowed to exceed 72. The first 20¼ miles were run in 20 min. 16 sec., when adverse signals reduced speed to 10 miles an hour.

In run 8 with a heavier load No. 4027 made an excellent start to Knowle, passing Solihull at a speed of 54 and increasing to 62 on the level. On this and in runs 9 and 11 Hatton was passed in under 19 min.—a rare occurrence with heavy loads. No. 4027's time of 24¼ min. for the 23¼ miles represents very satisfactory work.

In run 9 No. 4043 had covered 20¼ miles in 21¼ min. before being checked.

For runs 10 to 12 the same locomotive was employed, but worked by different enginemen. At the present time seven trains are shared by eleven sets of men. These three runs were checked in the early stage. The delay in run 10 was serious, causing 2 min. loss, and was responsible for the abnormal time of 11¼ min. to Solihull; but although only 14¼ min. remained in which to cover the remaining 16¼ miles, the run was made to time. Rapidly accelerating after the check, the engine passed Solihull at a speed of 57.1, Knowle at 66.6, then the next 6 miles were run at 69.2, 72, 76.5, 76.5, 78.3, and 73.4 miles an hour. The 10¼ miles to Hatton took only 8 min. 46 sec. Further effort being necessary, the driver ran down the bank at a maximum of 81.8, and made a smart stop, completing the run in 25¼ min.

In the next two runs with the same engine the initial delays accounted for smart running after Solihull. In run 11 with 296 tons the 10¼ miles to Hatton were run at an average speed of 68.3, while in the next run with 352 tons the average speed for the same length was 69.8.

The last three runs illustrate work with coach loads exceeding 400 tons. In spite of a slight check in run 13, No. 4027 saved a minute on the trip, covering 10¼ miles after Solihull at an average speed of 68.5.

The gross load of the seventeen coaches in run 15 was at least 500 tons, for the train was crowded. The rather severe slack had the effect of lowering speed to Solihull, where the rate was 48. Before Knowle speed had risen to 55.3 and quickened to 65.4 for 3 miles, finally attaining a maximum of 72. The 10¼ miles to Hatton took 10 min. 4 sec. These runs were made between the years 1911 and 1922 inclusive.

LEAMINGTON TO PADDINGTON.

The final stage of 87¼ miles, with its booked average speed of 57.5 miles an hour, is not so favourable as regards gradients; and, allowing for three speed orders for curves, the journey is practically a "mile-a-minute" run. The start is distinctly hard. The first 6 miles from Leamington consist of a sharp rise at 1 in 202 for the first mile, the second is easier, and the last 4 miles rise at 1 in 187 to post 100. The next 3 miles to post 97 are level, after which the gradient stiffens to 1 in 240 to post 94. Passing times at these points are given in Table B. When trains are heavy, the gradients on the initial 12 miles impose a severe test of locomotive power.

After passing post 94 there is a slight fall to Banbury, consisting of a mile at 1 in 179, and for 4¼ miles at gradients ranging about 1 in 350. Formerly the heaviest loads were taken only as far as Banbury, where several coaches were slipped. Reference to Table B shows that the impracticable timing of 22 min. for the 19¾ miles to Banbury was never adhered to. The next 5 miles to Aynho Junction are almost level. The favourable 12-mile stretch preceding this junction is one of which drivers must take the fullest advantage in order to keep time with heavy trains, as—after Aynho Junction—there is a rise of 4 miles at 1 in 200 to Ardley, and time is lost if this incline is approached at moderate speed. On the next 10 miles, high speed is the rule, the first 5½ miles forming the descent of the Bicester Bank at 1 in 200, followed by 2 miles of level, the next 3 rising at 1 in 200. Then comes a like descent of 2 miles to Ashendon Junction, where there is a curve over which a speed order to 50 miles an hour is enforced. The reduction appears unimportant, but the restriction is lengthy and occurs where gradients favour high speed.

A level stretch of 6 miles enables normal speed to be resumed, facilitating the ascent of the Risborough bank, which begins at post 28, and rises for 6 miles at 1 in 176, 1 in 200, and 1 in 167, on which incline some excellent work is performed. After an easy descent of 4 miles, speed is reduced to 35 miles an hour over the reverse curves approaching High Wycombe. Then 2 miles of level form a convenient stretch for recovering speed before facing a rise of 2¼ miles at 1 in 250 and 1 in 225 to Beaconsfield.

On the next 17¼ miles to Park Royal—beginning with the descent of the Denham Bank for 7 miles at 1 in 254 with a slight fall afterwards—fast running is usual.

At Park Royal, 4½ miles from Paddington, speed is again reduced to 20 miles an hour over the curve at the junction of the two main lines. Given a clear road, these 4½ miles take only 7 min., but checks are rather frequent.

As regards the stations and posts named in Table B, only those have been chosen which mark a definite change in the gradients.

RUNS WITH TWO-CYLINDER ENGINES.

Three runs by two-cylinder engines are given first. In run 16, No. 2942, with 302 tons, ran well throughout. The first 2 miles took 4 min. 13 sec., and a speed of 45 was maintained up the final 4 miles at 1 in 187. The 3 miles of 1 in 240 to post 94 reduced the rate from 59 to 55.3 miles an hour. Towards Banbury speed rose to 68, and the 9 miles before Aynho Junction were run in 7 min. 56 sec. The passing time of 22¾ min. at Banbury was good. The rise of 1 in 200 for 4 miles to Ardley was ascended at a minimum of 58.1, after which the descent of the Bicester bank produced a maximum of 81.8. The 18¼ miles to Ashendon Junction were run in 15 min. 42 sec., one of the best times for this length. By passing this junction in 43 min. 10 sec., the driver had made an average speed of 60, and also the second best time to this point.

Rapidly accelerating, the Risborough bank was climbed in the quick time of 6 min. 8 sec., opening with a rate of 65.4 and ending at 52.9, giving an average climbing speed of 58.6 miles an hour. Only the first 4 of the 6 miles descent to Wycombe are available for fast running, as the driver must reduce his speed to 35 miles an hour for a complete mile over the curves before passing the station. Another instance of good work was shown in recovering from this slack when speed rose to 59 for 3 successive miles up 1 in 225 and 250. The 17¼ miles to Park Royal occupied 14¼ min., the customary time for this length, the maximum speed being 81.8. So far the average speed from the start was 62.1 miles an hour, and in spite of a slight check the run of 87¼ miles was completed in 87½ min.

In the next four runs it will be noticed that coaches were slipped at Banbury, appreciably reducing the load after that station.

In run 17, with the heavier load of 376 tons the engine made a slower ascent, the sustained speed being 42 miles an hour. The short rise of 3 miles lowered speed from 56.2 to 52.1, and we did not exceed 70.5 to Banbury, where the load was reduced to 273 tons. After attaining a rate of 76.5, the driver voluntarily applied the brakes at Aynho, reducing his speed to 69.2, and then ran the 18¼ miles to Ashendon box in the extraordinary time of 15 min. 12 sec. at an average speed of 72. The first 4 miles up 1 in 200 were climbed at a minimum of 60, while the next 10 were run at an average speed of 77 and a maximum of 87.8 for 2 miles—quite a high figure for a six-coupled engine with a 30in. piston stroke.

That No. 2937 could run equally well on adverse gradients was shown by the subsequent ascent of Risborough bank; for, after a prolonged slow at Ashendon, the 6 miles were climbed in 5 min. 47 sec. at an average climbing speed of 62.2 miles an hour, the best time in the series. The actual speeds for the 6 miles were 66.6, 64.2, 62.1, 62.1, 60.5, and 58.1.

After passing High Wycombe 2 min. early, the engine was eased, the 17¼ miles to Park Royal taking 15½ min., a minute more than normal time. So far the 82½ miles had been covered in 82 min. 23 sec., and after the usual slowing down we arrived at Paddington in 89¾ min., having averaged 58.4 miles an hour for the run.

The uphill work of No. 2901, with 386 tons, in run 18, was a slight improvement on that of No. 2937 to post 94, but the pace to Banbury was easier. Then with 304 tons the driver accelerated to 75 miles an hour, rushing up the Ardley bank, 5½ miles taking 5 min. 6 sec. We took 16 min. 13 sec. for the 18¼ miles to Ashendon box, but at the foot of the Risborough incline—post 28—experienced a slight check, which affected the ascent, the 6 miles taking 7 min. 7 sec.

Slowing through High Wycombe a minute late, a vigorous recovery brought us to the summit of the 3 miles rise at a minimum of 61 miles an hour, one of the highest recorded rates at this point. The 17¼ miles after Beaconsfield were covered smartly in 14 min. 10 sec., without exceeding a maximum speed of 80; and as the engine was ¼ min. early at Park Royal, Paddington would have been reached in 90¼ min. but for two signal stops. The average speed for the first 84 miles was 59.

RUNS WITH FOUR-CYLINDER ENGINES.

With 378 tons, No. 4036, in run 19, maintained a rate of 43.3 on the ascent to post 100, and from a speed of 58.1 on the easier gradient fell to 50.7 on the rise of 1 in 240; but rose to 73.4 before Banbury and to 78.3 after.

With a load reduced to 275 tons, the 18¼ miles after Aynho accounted for 16 min. 2 sec., speed falling from 63.1 to 53.7 before Ardley, and rising to 80 down the Bicester bank.

The driver ran well up Risborough bank in 6 min. 1 sec. between speed limits of 66.2 and 53.1. After the Wycombe slow, speed recovered to 59 at Beaconsfield summit. Then followed another high-speed exhibition, the next 17¼ miles being run in 13 min. 47 sec. at an average rate of 74.7 miles an hour, which is almost the quickest descent, though the maximum did not exceed 83.7. The 70 miles preceding Park Royal were covered in 63 min. 12 sec., equal to an average speed of 66.4. For the last 4½ miles the driver had 9¾ min., and Paddington would have been reached in 88½ min. but for a signal stop.

No. 4026 excelled in both runs 20 and 21. On the former, with 325 tons, the ascent to post 100 in 9½ min. was good, the engine attaining a speed of 45 in 1½ miles from the start, and increasing to 46.1 up the 1 in 187. In the next 2 miles speed rose to 58.1, falling to 55.3 on the 3 miles of 1 in 240. A spurt to a maximum of 78.3 miles an hour brought us through Banbury only 50 sec. late. Thence with a load of 251 tons we continued at high speed, taking only 4 min. 4 sec. for the 5 miles to Aynho—where speed was 75—and rushing up the 4½ miles at 1 in 200

TABLE A.—*Snow Hill to Leamington.*

Run	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Number of engine	4042	2929	2909	2937	4030	2901	2926	4027	4043	4026	4026	4026	4007	4033	4030
Number of coaches	11	12	13	14	14	14	12	12	11	12	11	13	13	13	17
Coach weight (tons)	302	319	346	376	387	386	315	378	353	325	296	352	403	408	457
Schedule (minutes)	27	27	27	26	27	27	26	26	26	26	26	26	26	26	27
Miles. Snow Hill, dep.	m. s. *	m. s.	m. s.	m. s. *	m. s. *	m. s.	m. s.	m. s.	m. s.	m. s. †*	m. s. *	m. s. *	m. s. *	m. s.	m. s. *
3¼ Tyseley, pass	5 22	5 25	5 26	5 32	5 40	5 30	5 12	5 18	5 22	7 8	5 51	6 9	5 38	5 24	6 14
6¼ Solihull, pass	9 42	9 45	9 38	9 47	9 55	10 0	9 5	9 15	9 35	11 26	9 51	10 28	10 12	9 45	11 3
10¼ Knowle, pass	13 22	13 20	13 15	13 16	13 24	13 35	12 11	12 36	13 3	14 40	13 8	13 42	13 23	13 20	14 55
17¼ Hatton, pass	19 42	19 45	19 36	19 13	19 27	19 40	17 32	18 37	18 55	20 12	18 50	19 16	19 10	19 18	21 7
21¼ Warwick, pass	23 25	23 17	23 25	22 45	23 11	23 5	†	22 8	†	23 22	†	22 37	22 30	23 7	24 49
23¼ Leamington, arr.	25 46	25 48	25 48	25 5	25 37	25 26	26 3	24 18	27 40	25 40	26 42	25 2	24 51	25 27	27 21
Net time, minutes	25¼	—	—	24¼	25¼	—	23¼	—	24¼	23¼	24¼	24¼	24¼	—	26¼

* Slight check, loss than 1 min. † Severe check, 2 min. and over.

TABLE B.—*Leamington to Paddington.*

Run	16	17	18	19	20	21	22	23	24		25	26	27
Number of engine	2942	2937	2901	4036	4026	4026	4049	4049	4043		4027	4024	4030
Coaches	10	14/10	14/11	14/10	12/9	13	11	9	13		11	11	12
Coach weight (tons)	302	376	386	378	325	352	343	293	406		343	338	367
Load after Banbury (tons)	302	273	304	275	251	352	343	293	406		343	338	367
Miles. Leamington, dep.	mins. m. s.	m. s.	m. s.	m. s.	m. s.	m. s.	m. s.	m. s.	m. s.		m. s.	m. s.	m. s.
6 Milepost (a) 100, pass	9 22	10 29	10 15	10 10	9 31	9 36	11 25	9 26	10 26		9 57	9 39	
9 Milepost 97, pass	12 33	13 58	13 42	13 35	12 47	12 48	—	12 33	13 55		13 5	12 50	
12 Milepost 94, pass	15 41	17 17	17 13	17 2	15 58	16 0	19 10	15 33	17 21		16 0	15 54	
19¾ Banbury, pass	22 22 44	24 30	25 0	24 16	22 50	22 48	27 20	22 17	24 44		23 41	23 37	
										Miles.			
25 Aynho Junction, pass	27 27 28	28 49	29 2	28 25	26 54	27 3	32 13	p.w.r.	29 20	5¼	7 34	7 27	7 20
30¼ Ardley, pass	32 27	33 29	34 8	33 30	31 25	32 32	37 47	34 29	34 38	10¼	12 48	12 48	12 49
37¼ Milepost 6, pass	38 2	39 3	40 0	39 20	36 46	38 20	43 40	40 20	40 23	17¼	18 40	18 36	18 37
43¼ Ashendon Junc. (50 miles per hour), pass	44 43 10	44 1	45 15	44 27	42 8	43 42	49 10	45 26	45 29	23¼	24 0	23 47	23 52
49¼ Milepost 28, pass	48 29	49 32	Check	49 52	48 3	50 7	55 9	50 57	50 52	29¼	29 34	p.w.r.	29 20
55¼ Milepost 22, pass	54 37	55 19	55 26	55 53	54 23	56 36	61 23	56 49	57 24	35¼	35 42	39 36	35 45
60¼ High Wycombe (35 miles per hour), pass	63 60 33	60 55	64 0	61 55	60 30	62 53	66 48	62 10	63 26	41	42 25*	45 20	41 52
65¼ Beaconsfield, pass	65 32	66 55	69 5	67 28	66 0	68 52	71 47	67 42	69 12	45¼	48 16	50 45	47 25
77¼ Northolt Junction, pass	79 75 10	77 23	78 28	76 40	76 2	78 42	80 58	77 10	78 32	57¼	57 25	59 58	p.w.r.
82¼ Park Royal (20 miles per hour), pass	84 80 1 *	82 23	83 15 Stops	81 15 Stop	81 8 *	Checks	85 25	81 50 Stop	83 12 *	63	62 0	64 32	64 8 *
87¼ Paddington, arr.	91 87 25	89 46	90 25	90 32	89 25	90 17	92 15	93 49	91 28	67¼	70 0	71 48	72 20
Net time, min.	87	—	89½	88¼	88¼	90¼	—	86¼	90¼		69¼	68	69

* Slight check, less than 1 min. p.w.r. = permanent way relaying check, 3 min. or over. (a) The milepost numbers in the table do not indicate the actual distance from Paddington.

in 3 min. 47 sec. at a minimum of 62.1. In fact, No. 4026 equalled the feat of No. 2937 by running the 18¼ miles to Ashendon in 15 min. 12 sec., attaining the same maximum of 87.8 miles an hour. As a result, the passing time of 42 min. 6 sec. at Ashendon is easily first. The rest of the run requires little comment, the 6 miles up Risborough bank taking 6 min. 20 sec. between speed limits of 61 and 51. The average speed for the journey was 58.6.

On the remainder of the runs there was no reduction in the loads *en route*.

In run 21, with 352 tons throughout, the ascent of No. 4026 to post 100 in 9 min. 36 sec. is the best in the series, having regard to the heavy load. After taking 4 min. 22 sec. for the first 2 miles, the next 3 miles were run at a rate of 45, and the final 1 mile at 46.7—very sound work from a start on gradients of 1 in 187, and the passing of Banbury in 22¾ min. with this load was no less creditable. The subsequent running to Northolt Junction was normal; that is, if the running of 57¼ miles—including two slowings—in 55 min. 54 sec. with 352 tons can be so described.

In run 22 No. 4049, with 343 tons, had a driver who was new to the work. At Ashendon Box he apparently became aware that he was 5 min. late, for his subsequent effort resulted in his taking the shortest time thence to Paddington, running 44 miles in 43 min. 5 sec.

The 6 miles up Risborough incline were climbed in 6 min. 14 sec. at very even speeds, varying only from 59 to 54.5 miles an hour. After the Wycombe slack the driver accelerated to 59 on 2 level miles, and worked the engine to a rate of 63.1 on the rise of 1 in 225, the last mile being run at 61. This is the best effort at this point. The next 17½ miles to Park Royal were run in 13 min. 38 sec. at an average speed of 75.1; and, there being no check other than the curve slack, the remaining 4¼ miles took less than 7 min.

Later, the same driver and engine gave run 23. After maintaining a rate of 46.7 on the ascent from Leamington, the engine attained 62 on the 3 level miles to post 97, and fell only to 58.1 on the rise of 1 in 240, with the result that Banbury was passed nearer to the impracticable timing of 22 min. than on any other run.

A severe slack before Aynho Box caused 3 min. loss, but some striking work followed. The engine recovered to a rate of 58.1 on the Ardley bank, went over the summit at a minimum of 54.5, and ran the next 12¾ miles to Ashendon Box in 10 min. 47 sec. at a maximum of 83.7. Further, the 6 miles up Risborough bank were climbed in 5 min. 52 sec. at an average climbing speed of 61.3, and a minimum of 58.1. The uphill work throughout this run was of a high standard. The remainder of the run was of the ordinary character, Park Royal being passed 2 min. early. The train was stopped for 3¼ min. outside the terminus, but the net running time of 86¼ min. is the shortest.

On starting run 24 the idea of No. 4043 keeping time with a coach load of 406 tons was not entertained; but the fact that time was kept entitles this run to first place in order of merit. With luggage and passengers the full load was quite 440 tons. Speeds of 41.8 and 42.3 were maintained on the ascent to post 100, while the 3 miles at 1 in 140 reduced the rate only from 55.3 to 51.4. The driver took advantage of the easy gradients to Aynho to cover 9 miles in 7 min. 59 sec. Thus he was enabled to face the Ardley bank at an initial speed of 67.9, taking only 4 min. 25 sec. for the 4¼ miles with a minimum of 52.1. The usual time of 16 min. 9 sec. was taken for the 18¼ miles to Ashendon Box, 10 of them being covered at an average speed of 75.6 and at a maximum of 81.8. On the level after the slack speed recovered to 67.9. Then the 6-mile ascent was made in the remarkable time of 6 min. 32 sec., mile speeds being 64.2, 59, 56.2, 55.3, 50, and 48.6—excellent work with a load of 440 tons.

On the sharp fall to Wycombe the rate averaged 60 for 4 miles before brakes were applied for the curves, where speed was carefully reduced to 37 for the whole mile. On the next 2 level miles the engine accelerated to a rate of 54.5, after which 3 miles rising at 1 in 225 and 250 reduced speed merely to 52.9. The next 17¼ miles were run in exactly 14 min. at an average rate of 73.3, the fastest 5 miles taking 3 min. 38 sec. with a maximum of 85.6. The average speed to Park Royal works out to 59.6, and the 70 miles to this point were run in 64 min. 58 sec. These runs were between the years 1912 and 1922 inclusive.

SOME RECENT RUNS.

The last three runs are quite recent—last summer—specimens of work on the 2.55 p.m. ex-Birmingham. This train is allowed 24 min. from Leamington to a stop at Banbury, and 70 min. for the final stage of 67¼ miles to Paddington, the average speed for this length being 57.8. As compared with previous runs, the fresh start from Banbury robs the engines of the advantage of approaching the Ardley bank at equally high speed; consequently the work is harder. The starts were good and the times to Ashendon Box were very even.

In run 25 No. 4027 climbed the 6 miles up Risborough bank in 6 min. 8 sec. at a minimum speed of 54.5, and would have passed High Wycombe to time but for an additional check before the curve. The driver averaged 74.7 miles an hour between Beaconsfield and Park Royal, where he was a minute before time, slowing down afterwards to avoid an early arrival.

In run 26 a severe relaying slack for nearly 2 miles to the foot of the bank caused a loss of 3¼ min. After recovering to 60 at Beaconsfield summit the driver equalled No. 4027's speed to Park Royal and averaged 56.4 miles an hour for the whole run.

With the heavier load in run 27 the engine went up Risborough bank in 6 min. 25 sec. at a minimum rate of 50. After passing High Wycombe to time, speed fell to 52.9 at Beaconsfield. The 57¼ miles to Northolt Junction were covered in 57 min. 5 sec., although this station was passed at low speed due to a relaying slack which cost 3 min. When the driver slackened—for the fourth time on the run—through Park Royal he had contrived to cover 63 miles in 64 min. 8 sec. with 367 tons. On noting the arrival times of the last three runs it should be remembered that on the first two the engines were each slowed four times, and—on the last run—five times during the journey of 67¼ miles.

CONCLUSION.

Wolverhampton enginemen were responsible for twenty of these runs, and London men for the remainder. Much credit is due to them for such sound work, for on no occasion whatever were they aware that the running was being specially timed. The runs were timed from actual start to stop at almost every mile-post throughout.

The figures representing train loads are solely the empty coach weights, which are accurate to the nearest ton. Only in two exceptional cases has the full load been estimated.

It is a striking tribute to Mr. G. J. Churchward, ex-chief mechanical engineer of the Great Western Railway, that his four-cylinder locomotives, which were designed fifteen years ago, are still efficiently performing express work far more arduous than was originally contemplated. Since then the main improvement in the design has been the adoption of superheating. Two prominent characteristics of these locomotives are their hill-climbing abilities and power of rapid acceleration after checks.

Taking the ten unchecked ascents of Risborough bank—from post 28 to 22—as tabulated, the average time and load are respectively 6 min. 12 sec. with 320 tons, and the average climbing speed 58.1. The slowest ascent was 6 min. 32 sec. in run 24 with a load of 406 tons.

The British Industries Fair.

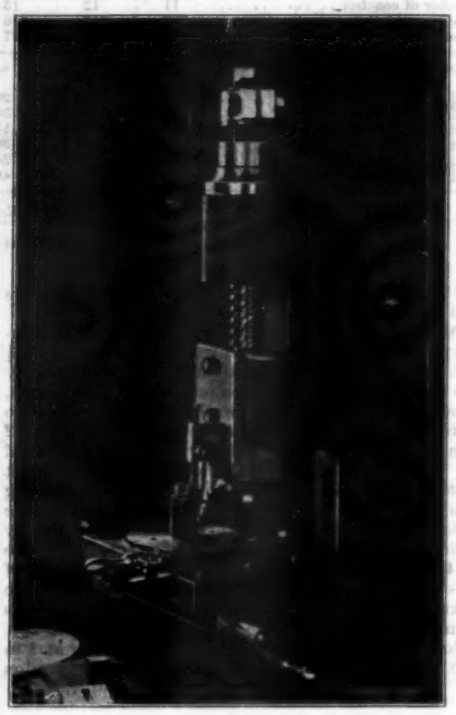
No. II.*

WE continue below our description of some of the exhibits at the British Industries Fair, at Castle Bromwich, Birmingham; but before going on to the engineering productions on the stands, it may be of interest to note that the British Engine Boiler and Electrical Insurance Company, Ltd., with a stand in Building B, is making the Fair an occasion for introducing to the notice of makers of plant a new scheme of insurance, whereby they are indemnified against the breakdown of the plant they manufacture during testing at their works, and also against the cost of repairs and replacements they may be called upon to make, under the terms of their guarantee to purchasers, to remedy defects consequent on faulty workmanship, material, or design. The advantages claimed for this scheme are that uneven results, caused by the fluctuation of the cost of such repairs, are eliminated by the payment of a premium, which is a fixed percentage of the turnover, and that the expert inspection service rendered during the guarantee period helps towards the proper installation and working of the plant by the customer, while it reduces the possibility of breakdown to a minimum. A unique feature of this form of protection is that each policy is separately drawn up to suit the individual requirements of the maker in question.

The Rhondda Engineering and Mining Company, Limited, of Bridgend, Glamorgan, is again showing the Draper coal washing machine, which we described in connection with last year's Fair, and the representative of the company told us that no occasion had been experienced for altering its general design. On the other hand, however, as showing the wide scope of its application, he mentioned the fact that one of the machines is at work in East Africa washing soda. At Magadi the machine is used to wash the soda crystals, dredged up from the bottom of the lake, to free them from foreign matter. The saturated solution forming the lake itself is used for the washing and is returned to the lake again. Another Draper washing plant is in service in France washing sand to free it from clay. The resulting material is 98 per cent. silica, which will pass through a 100 mesh screen.

The Brooke Tool Manufacturing Company, Limited, of Warwick-road, Greet, Birmingham, has a fine exhibit of engineers' small tools, including milling cutters, reamers, end mills, twist drills, circular saws, taps and dies, and so forth. Among the reamers there is a new form of the expandable type having spiral flutes, which can consequently be effectively used in key-seated or oil grooved holes. They are made in sizes ranging from ⅛in. to 2in., with expansions ranging from 0.008in. to 0.015in., according to their diameter. Another novelty is a circular saw with inserted teeth of high-speed steel, while an interesting item is a set of plain thin discs used for rolling across sheets of soft caramel, and thus cutting it up into the familiar sweetmeats. Although this does not appear to be a very onerous service, we were told that it requires quite a special class of steel, and that while the surface must not be rough it must not, on the other hand, be polished too highly.

Messrs. G. Twigg and Son, of 57–63, Moseley-road, Birmingham, are showing a special form of machine vice primarily intended, in combination with an ordinary hand screw press, for use in cutting dies, punches, &c. As will be seen from the illustration, a tool box is fixed on the ram of the press, and the vice screwed to the bed below. The vice is provided with slides, so that it can be moved in any direction, and one type also has a rotary table. The work is fixed on the table, and if it is desired to give a taper relief to the dies a wedge-shaped plate is arranged below the working table. The tool box is provided with a



TWIGG DIE-SINKING PRESS

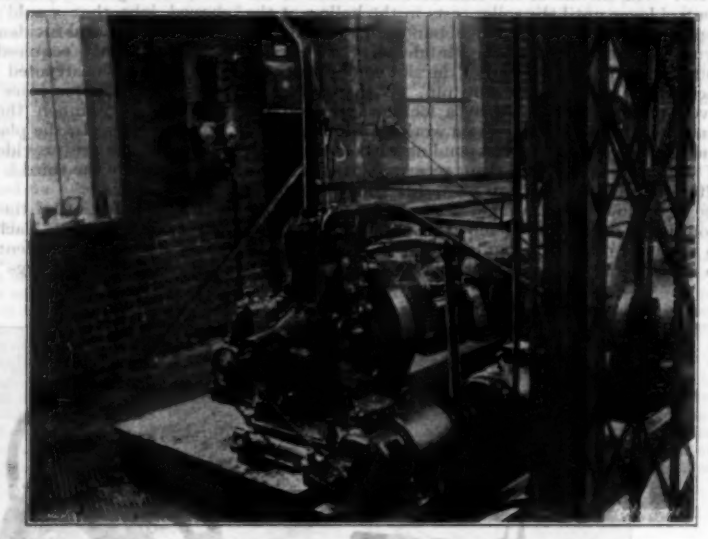
clapper action to relieve the tool on the return cut. The idea has the great merit, as compared with the use of an ordinary slotting machine, that the hand operation gives a much more delicate touch, while the cut can be taken right down to a shoulder. As against hand chipping it is both more accurate and faster. Some of the work turned out by the machine and shown on the stand—the die for a very small pinion wire, for instance—shows a very neat and accurate finish.

The Brian Engineering Company, Limited, of Cardiff and Birmingham, is exhibiting some automatic weighing machines primarily intended for the milling trade, but in view of some remarks during a recent discussion at the Institution of Mechanical Engineers, we asked if they would work satisfactorily with chemicals. The machines, we were told, have been tested in such services, and even when weighing sulphur, had a maximum error of 0.07 per cent., providing the material was kibbled so as to reduce the larger lumps. In the Vibra weighing machine, made by this company, the beam is equal armed, and has at one end the weigh bucket, while the other carries the weight box. The feed gate, through which the material to be weighed is fed into the weigh bucket, if left quite uncontrolled, would remain wide open, because its "opening weight" will carry it past the hopper opening. It is partly controlled, however, by a "feed gate-counter weight," an independent lever which, when permitted to fall, overcomes the feed gate opening weight and thereby keeps the feed gate closed. The counterweight bears heavily upon a "falling arm" so shaped and placed that the part of it nearer to its pivot cannot fall past the bucket end of the beam, which is provided with a contact to intercept it. Whenever this beam arm moves upwards it will force upwards also the falling arm, which will in turn carry upwards the feed gate-counter weight, that will, therefore, cease to control the feed gate. On the other hand, when the same arm of the beam swings down the falling arm, &c., will follow it, but just before the beam reaches the horizontal position the falling arm will be arrested—and the beam relieved of its weight—because a nose-like projection of the falling arm

* No. I. appeared February 23rd.

meets the roller end of the "trip trigger." When the unloaded bucket, unable to balance the loaded weight box, swings upwards, its beam arm levers upwards the falling arm and the feed gate-counterweight. The feed gate is free to open and, in fact, will now be quite open. The material to be weighed falls rapidly from the hopper into the bucket, and shortly there comes the time when the aggregate weights of the bucket, the accumulating grain, the falling arm and the feed gate-counterweight force downwards the bucket end of the beam until the

NEWTON PLANING MACHINE DRIVE CONVERSION



WEBBER GAS DRIVEN COKE HOIST

falling arm meets the trip trigger. At this position the feed gate counterweight has descended sufficiently partially to shut the feed gate and reduce the feed to a dribble. The slightest further downward movement will cause the dribble to be instantaneously cut off. This condition is brought about by the dribble itself. As the grain trickles into the bucket, gradually bringing its contents to the desired weight, the beam first ceases to press upwards upon the arrested falling arm and gradually comes free towards the horizontal position. Immediately the required weight of grain has passed the feed gate, but when as yet the quantity ascertained and compensated for at the first weighment is still "in transit," and the beam swings to the horizontal position, the side bracket on the bucket lightly touches the trip trigger and releases the falling arm. The feed gate is at once shut. A moment later the falling arm, with a sharp blow knocks out the bucket door catch and the weight of the accumulating material promptly forces open the bucket door in spite of its counterweight, swinging it right back into a position which is very nearly, but not quite, stable. As long as any grain is falling from the bucket, however little, the bucket door will not close; nor will it close if there is any obstruction. But normally, as soon as the bucket is empty, the door begins to close and it gathers speed and momentum as its counterweight comes more effectively into action, the swivel-link is rotated backwards to its original position, the catch slips back, and the bucket door is again secure. The lock-lever then falls and the feed gate swings open to start the next weighing. The whole sequence will probably have lasted 15 seconds. It is possible to test the accuracy of any weighing by a very simple process, while the amount of material which is still falling freely after the feed gate has shut, and has not yet arrived in the weigh bucket may be exactly compensated for.

Accles and Shelvoke, Limited, of Talford-street Works, Aston, Birmingham, have a selection of small direct-current motors, ranging from $^1/_{10}$ up to $\frac{1}{4}$ horse-power, some of which are shown driving pumps for water and a motor car tire inflator. There are, also, in the way of distinct novelties, a "Humane" cattle slaughtering pistol, and a small adjustable spanner. The latter has a comparatively fine pitched thread and a ball bearing thrust, so that a very powerful grip can be got with the jaws, so powerful, in fact, that small round work can be screwed up with it. The tool is built up principally of drop forgings acetylene-welded together, and is a very workmanlike production. The cattle slaughterer, also, is a nice piece of work, and drives a long bolt into the beast's head by means of a small cartridge that is exploded in a closed chamber. The bolt is immediately withdrawn by the compression of air in front of a piston attached to its rear end. The makers told us of the rather surprising fact that it was only after extensive experimenting that they discovered a class of steel which would stand up to the work imposed upon the bolt.

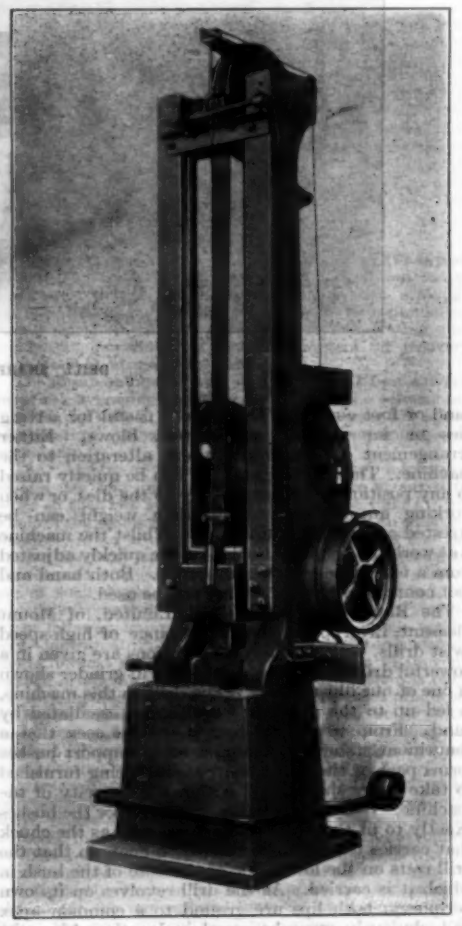
Mark Webber, Limited, Church Acre Works, Guildford, is exhibiting a neat little 2-kilowatt electric lighting set driven by a single cylinder oil engine, and equipped with a semi-automatic control system possessing several novel features. The stand is also decorated with a number of photographs, showing applications of the Webber engine, one of which we reproduce. In this case the engine is used to work a hoist for raising coke in a gas works, as the management did not wish to take a supply of electricity from the town mains to work it. A 16 horse-power Webber two-cylinder gas engine was thus installed together with a dynamo and motor, as shown in the engraving. The dynamo charges a storage battery that supplies current to the motor for starting the engine, which, in turn, drives the hoisting gear. All the operations of starting and stopping are effected automatically when the lift rope is pulled. The engine developes its full load for only 20 seconds at a time, when raising a useful load of 15 cwt., and it will be readily appreciated that it was no easy matter to get the engine to respond so rapidly to the sudden demand for power.

Newton Brothers, of Derby, are exhibiting a new range of alternating-current motors, specially designed for export work, and an epicyclic form of gear-box for driving planing machines, which has been produced with the idea of enabling the owners of more or less old-fashioned planing machines to run them at the speeds generally only associated with modern

ALLDAYS SPRING HAMMER

machinery. One of the chief obstacles to the attainment of high speeds on old planers is, of course, the great inertia of the driving gear that has to be overcome on the reversal at each end of the stroke. This inertia is often a much more serious consideration than that of the table and work itself. The Newton gear, of which we give an illustration, takes advantage of the epicyclic type of gear to avoid the necessity for reversing the direction of rotation of any part except the final driving shaft. The gear wheels are mounted in cages free to rotate on their shafts, but capable of being held by means of brake bands. The brakes are operated by electric solenoids that are energised from switches tripped by the usual gear on the side of the table. Only one brake is on at a time. With one of them held the cutting stroke gear takes the drive, while if it is released and the other gear held by its brake, the direction is reversed and incidentally the speed of the table increased. The gear is generally driven by an electric motor, but can, of course, be connected with the line shaft by a constantly running belt. In the case of one machine the new drive enabled the cutting speed to be increased from 37ft. to 40ft. per minute, while the reversal was made much more positive. Thus ten double strokes 8ft. long could be made in 2 min. 42 sec., as against 4 min. 24 sec. before the alteration, while for a short stroke of 1ft. the gain was as much as the difference between 0 min. 24 sec. and 1 min. 8 sec. In the case of heavier machines even better results than these have been obtained.

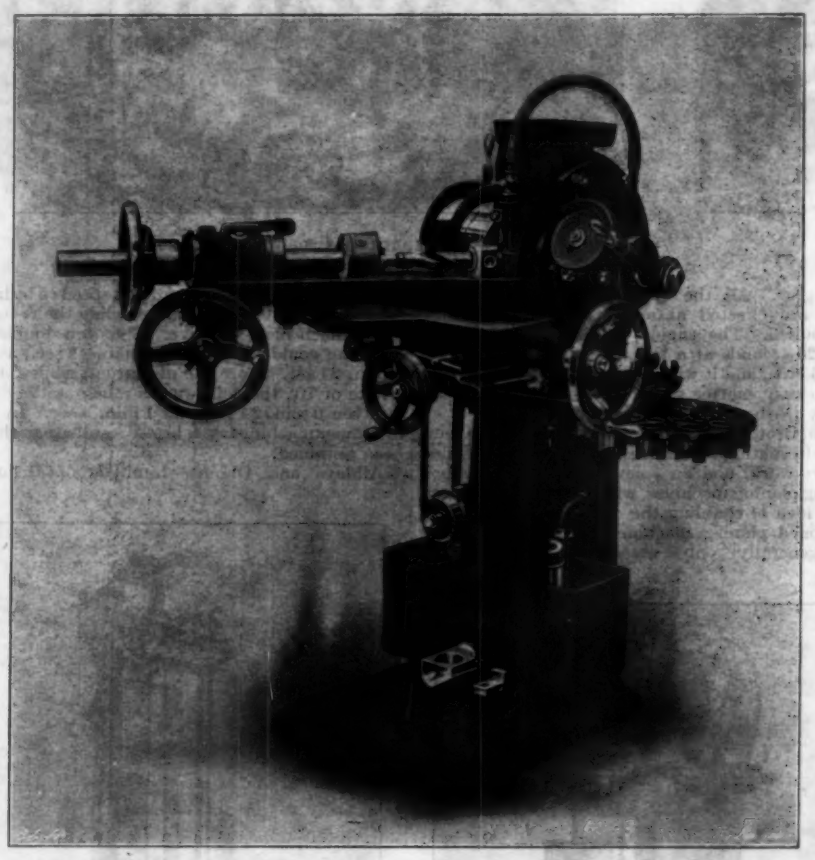
Alldays and Onions, Limited, of Birmingham,



ALLDAYS DROP HAMMER

have, among other machines, a new form of spring hammer, which we illustrate, an automatic drop stamp, a pneumatic planishing hammer, a riveting machine, and sundry blowers. The drop stamp, of which we give an illustration, is a self-contained

unit with the driving shaft and gear fitted low down at the back, close to the anvil block, so that the pull of the belt does not affect the stability of the machine. The clutch for actuating the lifter is of the spring band type and comprises a steel band lined with Ferodo wrapped round a friction drum keyed on the lifting shaft. One end of the steel band is fastened to the lifter arm, the other end is attached to a crank actuated by clutch lever. A hand lever is attached by a link to a slotted disc which is cam shaped. When the control lever is depressed the disc is turned round and engages the cam with a roller on the clutch lever. The incline of the cam moves the end of the control lever until the roller rests in the hollow at the top of the incline, when a steel band grips the friction drum and the whole of the clutch parts are carried round with it until the end of the slot comes into contact with an adjustable stop pin. With the control lever depressed, and held by a locking screw on the quadrant, the hammer goes on working automatically and lifts to a height corresponding with any position of the stop pin. The tup returns automatically, after each fall, to the top of its lift ready to deliver the next blow. The hammer can be arranged to strike from forty to a hundred blows per minute according to the type of work being operated on. In addition to the automatic gear, a light relay clutch is fitted for



DRILL SHARPENING MACHINE

hand or foot control. This is very useful for setting dies or for striking intermittent blows. Either arrangement can be used without alteration to the machine. The hammer and tup can be quietly raised to any position or lowered gently to the dies, or when working automatically the falling weight can be arrested at any point of its fall. Whilst the machine is at work the height of the lift can be quickly adjusted from a few inches to the full stroke. Both hand and foot control are fitted. Either can be used.

The Rapid Cobalt Company, Limited, of Mount Pleasant, Liverpool, is showing a range of high-speed twist drills, with which demonstrations are given in a powerful drilling machine, and the drill grinder shown in one of our illustrations. The drill, in this machine, is fed up to the grinding wheel and is oscillated by hand. From the illustration it will be seen that a convenient stand for holding a set of support bushes forms part of the equipment, bushes being furnished to take every size of drill within the capacity of the machine. It is not necessary, however, for the bushes exactly to fit the drills being sharpened, as the chuck that carries the drill is arranged to float, so that the drill rests on the lower side of the bore of the bush in which it is carried. As the drill revolves on its own periphery, both lips are ground to a common apex and obviously must be equal in length. After the sharpening operation has been completed, the drills, when necessary, may be thinned in the web without removing them from their original setting. For both sharpening and thinning processes the drill remains in the chuck and supporting bush, it being necessary merely to move the cross slide from one position to the other for the grinding wheel used for the thinning operation to engage with the drill, no re-setting whatever being called for. The thinning mechanism comprises an auxiliary grinding wheel spindle driven from the main spindle through friction rollers, which engage automatically when the wheel is moved down towards the drill. Mounted on ball bearings throughout, the device swings around the main shaft, and may be adjusted radially for height by the movement of a knurl screw that comes into contact with a stop that is placed conveniently.

The Selson Engineering Company, 85, Queen Victoria-street, London, is showing quite a number of novelties, among which there is a new type of machine vice. It is primarily intended for gripping awkward-shaped jobs that would not be firmly held in the ordinary vice, and incidentally reduces the amount of work frequently required on the setting-out table. The vice is constructed on the principle of three-point suspension, in place of the usual plain two jaws, and has very much the appearance of the usual machine vice. In the place of the normal jaws three sliding blocks are provided, two of which have fixed centres, while the third is a screwed centre for cramping the work.

The preparation of the work before placing in the vice is very simple. Each centre is capable of sliding in its groove independently of the others. Lines are scribed with "odd legs" on opposite sides of the work parallel with the basis line of the face to be machined. A "pop" is made with a centre punch on one line, and two centre "pops" on the other line, the latter being naturally arranged within the limits of the vice. If necessary, small holes can follow the "pops" for heavy work, but in any case the preparation is only a matter of a few minutes. It is noteworthy that this preparation is, in most cases, the only lining out necessary for the correct machining of the most difficult and odd-shaped castings or forgings; moreover, the existence of the three "pops" establishes a permanent basis for all other machining operations on the work, and saves considerable skilled time. For instance, the work can, if necessary, be taken from a vice on the milling machine, after the necessary facing is done, and cramped in a vice under the drill press, with certainty of correct location, set up, fair and square, without any trouble. We noticed, in exploring these vices, that the makers have such confidence in their principles that they are actually used in the manufacture of the vices themselves, and each has the three tell-tale "pop" marks on its faces. The sliding housing is held to the vice body by a T bolt running in a slot. The T bolt is arranged in the centre of this housing which pivots round this centre, arrested at any required angle by a plunger ratchet on either side, the ratchets falling into corresponding grooves cut across the surface of the vice. The housing can thus be swivelled to accommodate awkward articles, and no matter how difficult the shape may be from a grippable point of view, the three points will hold it just as firmly as they would a regular shape. For such cases as those in which the job is so big that it would not be adequately supported by the three points alone, loose centres which may be applied at any convenient places are also provided. Another novelty on this stand is a dividing head, designed to be used on milling and drilling machines and other machine tools, and is especially useful for holding and rotating circular work, such as discs, cones or cylinders, in order to present successive portions to the action of the cutting tool. It comprises a rotatable face-plate, 6in. diameter, having T slots and a central ⅝in. hole, by which work or special fixtures may be attached. The hole is accurately formed to carry plugs for centering work. The edge of the face-plate is graduated in degrees, and the plate can be locked in any position of rotation. A graduated swivel enables the axis of the face-plate to be set at any angle from vertical to horizontal, and a convenient means of locking is provided. Accurate steel division plates engaging a hardened steel pawl may be used for quickly dividing the circle. These dividers are interchangeable and are supplied with any numbers of divisions. Dogs and bolts are supplied to fasten the dividing head to the machine table, upon which it may be set squarely by the machined edges of its base.

Some Mechanical Problems in the Rubber Industry.*

By H. C. YOUNG, of Birmingham, Associate Member.

(*Concluded from page* 197.)

Weighing and Transporting of Drugs.—The mill drug room is an important department, the drugs and powder requiring the most careful weighing. Some of the drugs are in weight less than ½ per cent. of the batch, and a very much smaller percentage of the bulk. Most plants use zero shell weighers operated by hand. Attempts have been made to set up automatic weighers at each bin, which are so synchronised as to deliver a correct batch to the pan as it traverses the line of powder bins. A simple scheme has also been attempted for conveying the pan past each weighing station; as a pan passes under a weigher it is placed so as to catch the automatically weighed-out drug in proper sequence, the pan being check weighed by hand at the end of the run. Owing to the powders in use clinging to the scale and building up there, it is found difficult to obtain correct weights each time.

The transport of the drugs has always been by hand truck to the mill. It has been proposed to convey the drugs to the back of the mill by conveyor-belt, but this is difficult, unless used in conjunction with automatic mixers; this system would show advantages, provided a large output of any one stock was demanded. Dust control and collection are difficulties met with in handlir g drugs, more so since, under the recent Factory Act, all rubber mixes containing more than 5 per cent. of lead-mix come under "lead and fume process." As there is a considerable movement of powders in the open when weighing, checking, and mixing, exhaust fans of considerable capacity must be used. It is sound policy to have these exhausters as near as possible to the point of disturbance, but as the powders used are light, high velocity must be avoided. As most of the powders used in the industry are, under favourable conditions, good conductors of electricity, it is well to have a pipe-ventilated type of motor, unless it can be housed outside the department.

Waste Powders.—In a mill, with these points not closely watched, as much as 3 per cent. waste powder can be created, but with care and attention to lay-out this can be reduced to ½ per cent. or under, and, if the method of collecting be by vacuum even this waste may be converted to useful stock. It is for this reason that line-shafts and bearings are best clear of the floor, the bearings being hooded to permit salving of the dust.

Powders.—The powders used in rubber mixes should be dry and free from foreign matter, and the powder particles should be extremely fine. Although the powders may be purchased under specification, the rubber manufacturer would be unwise to use them direct from the bags or sacks as received, owing to dirt inclusion whilst packing, transporting, and unpacking. About fifty or more powders differing in specific gravity, weight per cubic foot, fineness, &c., may have to be treated, and when providing conveyors, driers, sieves, and storage bins, the nature of each powder must be considered. In laying out the powder plant, the engineer will realise the necessity for conveying by means of bucket elevators, but in many cases it will be found more convenient to convey by means of worms.

Drying.—Several types of drying machines have been tried, the principal of which are:—(1) Rotating drum type: An efficient drier when the walls are systematically cleared, but there is a tendency for the damp powder to cake on the walls and retard the drying. (2) Steam-cased worm-conveyor type: This has not proved very efficient. (3) Rotating steam-heated pipe cage type: This machine has given the most satisfaction, for it is adaptable to all types of powders, and its speed and temperature can be readily adjusted to suit powders of varying moisture content.

Sieving.—There are numerous standard sieving machines available, the principal of which can be divided into three classes:—Class I.: Shaking reciprocating sieves, often known as "dicky" sieves. Class II.: Centrifugal sieves. Class III.: Brushing sieves.

Class III. is suitable for all powders and its output is good. It, however, is costly on maintenance, owing to the short life of the sieving cloth, which is due to the continual rubbing by the rotating brush. Considerable trouble is given with this class of sieve on account of the sudden bursting of the cloth, allowing the powder tailings to fall into the sieved powder.

Classes I. and II. have proved entirely satisfactory. The maintenance cost of the former type is exceptionally low, but it is not suitable for all powders. The centrifugal

* The Institution of Mechanical Engineers.—Abstract.

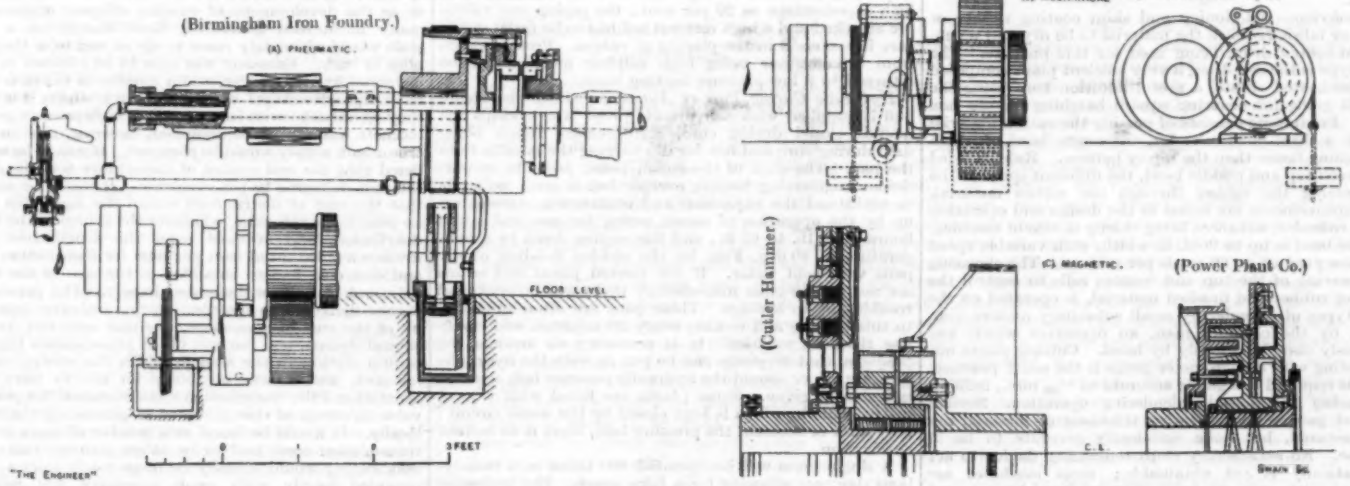
machine has proved satisfactory for all powders; the maintenance cost, however, is greater than that of the dicky sieve, and an additional disadvantage is the difficulty of removing the tailings completely.

A usual practice is to place the dicky and centrifugal sieves in series, the usable tailing being run through a small grinding mill and returned by conveyor to the powder circuit.

Storage.—When providing storage bins the sizes required must not be calculated from the specific gravity of the powder. The specific gravity refers to each individual particle, and not to a mass of particles. It, therefore, is necessary to find by experiment the weight of a standard volume of massed powder. The ratio of the actual weight of a cubic foot to that calculated from the specific gravity ranges from 0.068 for lampblack to 0.445 for magnesia sulphur.

Washing, Warming, Masticating and Mixing Mill Drives.—Dealing with the type of motor—assuming that alternating current is being used—a selection may be made from the following: the standard slip-ring type induction motor, the "corrected" induction motor, that is, the induction motor fitted with a phase advancer or vibrator, the synchronous motor with damper windings for starting, and the synchronous induction motor. If the power factor is not very important, and the first cost has to be kept down to the lowest point, the ordinary type of induction motor may be selected. If, however, the power factor is of considerable importance, as is often the case when power is purchased, one of the other types of motor mentioned may be adopted with advantage. The comparatively slow speed of the various milling operations makes the motor drive an important question of equipment. The back-line shaft speed in American practice does not exceed 120 revolutions per minute, and is as low as 56 revolutions per minute in British and continental mills. To keep the mill gears within reasonable dimensions, the average speed of the back shaft should be 75 revolutions per minute. This means that there is a reduction of 6 or 7 to 1, from the motor speed somewhere in the region of 400 revolutions per minute. In this country 95 per cent. of mill drives are of the gear-reduction type.

FIG. 4.—*Three differently Operated Brakes and Clutches.*



They can, however, be accomplished by worm, chain, and in some cases by motor direct.

Gear Reduction.—Because of the ratio necessary between front roll speed and motor speed, gear reduction requires the speed of the motor to be low; most gears supplied are double helical and leave much to be desired. In general, neglect and carelessness cannot be the cause, as the plant suppliers have helped in attempts to surmount the trouble. If the efficiency of this type of reduction gear is good at its installation, it must fall away very much as wear takes place. It would appear that the coarse pitch adopted to suit the heavy variable loads which take place, does not make for the even running of the gears.

Chain Drives.—This form of drive is being installed to some extent in America, with, it is claimed, considerable success. If the speed of the chain is kept low it runs quietly. With special design of spring-loaded sprocket-wheels, they are well able to accommodate the shocks set up by such loads as are common to rubber machinery drives. Ease of inspection, and definite means of taking up wear, are points in favour of chain drives.

Worm Reductions.—Worm reduction drives have been adapted to calender and forcing machines, which take anything from 15 to 250 horse-power; but these loads are not subjected to sudden fluctuation as are those of mixing mills. The worm reduction has been installed where individual motor drives have been used for mixing mills. This reduction is in operation also on a battery of mills where the motor is placed midway on the line. Quietness, compactness, and the use of high-speed motors are the chief claim for the worm reduction.

Direct Drive.—The practice of increasing the mill speed has rendered it possible to drive the line shaft direct with a motor, electrical engineers meeting a similar problem on a large scale in the electrical propulsion of ships. Synchronous motors up to 1000 horse-power have been installed in American rubber mills, but the author is not aware of an example of this drive existing in Europe. The installation has increased efficiency, floor space, maintenance, and simplicity in its favour.

Coupling and Clutch.—It is desirable that the very best form of coupling and clutch should be installed, and that the motor be relieved of shock and vibration. The clutch must be designed so as to be operated from any point along the mixing line. The magnetic clutch (C)—Fig. 4—enables this to be done simply; clutches operated by compressed air (A), and others purely mechanical in form (B), can be operated in much the same manner. It is necessary for the clutch gear to be absolutely reliable, and large dimensions and robust construction of small details are good steps towards this end. The brake operates with the clutch in all three types of gear. The clutch is usually placed between the motor and reduction gear, but the retardation curves indicate that because of the fly-wheel effect of the large gear, it is questionable whether the clutch should not be between the gear and the mills.

Line Shaft.—Practically all mill line shafts have ring-oiled bearings, but it would be economical to install roller or ball bearings and arrange a continuous bed, if necessary, for this purpose. A few rubber mill drives have had fly-wheels installed. With induction motors the percentage of slip must be arranged for the fly-wheel to be effective. The recording charts of a mixing line give some indication as to the possible usefulness of fly-wheel application.

Canvas and Fabric Spreading Department.—The material for the various purposes is received in rolls from 48in. to 84in. in width, and from 50 to 300 yards in length, which weigh up to 500 lb. The transport of the material through the various processes presents a problem calling for closest attention. In addition to the weight and bulk of the material itself there is that of a lining of similar length and width which must be introduced during the rubbering process to prevent the treated surfaces adhering when the material is rewound or batched on a roller known as a "box roller." This lining remains in the material until the fabric is finally introduced into the tire, shoe, and hose, &c., as an integral part.

The rolls are usually man-handled, and transported by electric trolley from operation to operation. The linings pass through all the processes and return to the starting point. If they become torn and dirty, or if rubber adheres to them, they must be dealt with in a repairing and cleaning section. The weight of a 72in. roll of cotton tire duck is approximately 500 lb., and after the various soaking, spreading and calendering operations this is increased by a further 500 lb. together with the lining which is about 300 lb.; the total weight with the "box" roller—100 lb.—is approximately 1400 lb. Since this roll must be weighed, after each stage, suitable weighing apparatus has to be installed, usually of the crane hook type, fitted where overhead runways are made to pick up and feed the machines. By arranging stocking rails at the correct height, and suitable for carrying the "box roller" which should be standard for any given equipment, hand lifting is not necessary. Electric and hand trolleys can be fitted with a saddle which, when butted up against stock rails, allows the bale of material to be rolled on or off the trolley.

Linings.—The present practice in cleaning is to pass the lining over an exhaust vent working with a 5in. vacuum, which frees it of dust and most of the loose foreign matter. This method has been introduced as an alternative to brushing the linings with a view to reducing labour and wear. The vacuum pipe is somewhat of a failure, as it removes only the surface dust; and the lining is held so tightly against the vacuum opening that the wear is greater than that of a brush.

Dough and Solution Making.—The method of dough and solution making is to take the mixed rubber from the mill and to sheet it out, and soak in a solvent, such as naphtha, for a period of twenty-four hours, after which it is churned in a hopper by paddles, until it reaches the desired consistency, further quantities of the solvent being added from time to time. Measurement and supply of solvent, and filling and emptying the hoppers, are the problems to be dealt with, and though the plant is simple the main consideration is one of detail improvement rather than of radical change. The old method, which is to a large extent still employed, is to receive the solvent in drums, from which supplies are drawn in buckets, the measurement being done in quart or gallon measures. Such a system with a volatile liquid is wrong because of the enormous waste of solvent, vitiation of atmosphere, inaccurate measurement, and risk of fire. The latest practice in handling solvent is by a pipe system from the rail or road wagon tank, discharging direct to the storage tanks and from there to each machine or hopper.

Measuring of Solvent.—The old method, that of measuring by hand into calibrated buckets or gallon or half gallon measures, is slow and wasteful. Meters are now available, but they are mechanically too delicate to stand up to continuous working, and are not reliable for measuring small and intermittent quantities. The measuring pump is also inadequate for use on long lines.

Sheeting and Letting Down, or Steeping Rubber in Solvent for Dough and Solution.—This operation is still manual, and a satisfactory mechanical alternative has not yet been evolved. It is necessary to soften the rubber sufficiently for the subsequent operations, the method found most suitable being to mill the rubber into thin sheets on a sheeting mill and to lay in solvent boxes from twelve to twenty-four hours. The most recent mechanical attempts to do this failed because no means were provided for removing the static electrical charge before the rubber reached the naphtha.

Mixing of Steeped Rubber into Dough and Solution.—The old method of performing this operation was to work the rubber and naphtha after letting down for twenty-four hours in solvent, on rolls similar to mixing rolls, which were fitted with scrapers, and the dough worked until the product was homogeneous. This method means higher power consumption and greater evaporation loss, but the quality of the product is decidedly superior to the one obtained by the modern method of using enclosed hoppers, which have the disadvantage of allowing lumpiness and powder caking. There is undoubtedly scope for a machine using a combination of the dough mill and the hopper which might successfully embody the best features of both machines. The cooling of the machine and blades might also be undertaken.

Transporting of Dough and Solution.—The transporting of dough, such as is used for spreading tire-ducks and garment proofings, presents no special problems, as a pipe system is out of the question, and it is most convenient to transport it in boxes, an essential being that well-fitting lids are provided to prevent solvent evaporation. For conveying rubber solution to impregnating or soaking machines, spreaders, packers, &c., pipes have had been used in America, but are not used in this country, with one, or perhaps two, exceptions. The advantages of such a system are many, including, low labour cost, diminished evaporation losses, increased cleanliness, and less vitiation of the atmosphere.

Impregnating (Soaking).—Impregnating or soaking of canvas fabric, &c., in rubber solution is principally confined to tire work, where the cotton used for carcases, &c., is packed and insulated with rubber to minimise chafing.

Soaking.—Every manufacturer apparently installed plant to his own ideas, and very few standard machines are in use. The best known is the continental type, the main features of which are: (1) Enclosed dip bath; (2) adjustable driven rollers for squeezing surplus solution out of cloth; (3) drying operation continuous with soaking; (4) naphtha vapours carried off by air current circulating round enclosed circuit, consisting of evaporating and condensing portions; (5) condenser system for recovery of solvent at atmosphere pressure.

The disadvantages of this system are: (1) Low solvent recovery, averaging about 65 per cent. of the solvent fed into the dip bath; (2) low output owing to very low speed of operation. Normal running speed is two cloth yards per minute.

The American plant for impregnating introduces several new features: (1) Two dip tanks are arranged in series so that two soaks can be given at one run; (2) the whole of the soaking and drying is carried on in an enclosed chamber, in an atmosphere of inert gas, such as flue gas from a specially controlled boiler or mixture of carbon dioxide and nitrogen from a gas producer. The correct use of such a gas removes fire or explosion risks; (3) solvent evaporated is recovered by "dead" gas circulating as follows: impregnator—condenser—blower—scrubbers—impregnator; (4) pressure in impregnator is atmospheric, or just sufficiently above atmospheric to prevent leakage of air inwards, *e.g.*, $^1/_{100}$in. water. There is only one such installation in this country. The gas is produced by means of an ordinary locomotive type boiler with mechanical stoker with means for carefully controlling air supply. The gas must be cleaned and chemically corrected before passing into the chamber.

Impregnating and Drying Chamber.—This consists essentially of a sheet iron chamber containing two dip baths, rollers for running the cloth through and steam radiators for drying out the solvent. Alternate rollers are driven outside by chains. At least two speeds should be provided—a normal running speed and a slow speed. A reel-off for the cloth is fixed outside at one end, and a take-up for the impregnated material at the other end. One of the main difficulties is to regulate the stretch of the material in passing through the machine, consequently some form of constant tension take-up is essential. Another difficulty is to keep creases out of the material, and no satisfactory means of doing this have yet been found, owing to the sticky nature of the cloth after impregnation.

Recovery Units.—These comprise a condenser and scrubbing plant. The condenser must be of ample capacity to keep the gas velocity low, in order to prevent condensed solvent being carried along mechanically in the

form of drops or spray. Manufacturers often supply condensers based on steam practice, which are quite inadequate. About 80 per cent. of the solvent should be recovered in this condenser. The gas and uncondensed vapour then pass to some form of scrubbing plant.

Spreading.—This is largely carried out on tire work, waterproof garments, aircraft fabric, and proofed materials of all descriptions. The type of spreader generally in use has not changed during the last twenty years, and a cruder machine could scarcely be imagined. The main improvements of the ordinary types of spreading machine have been made at the instigation of the users, and not by the makers, and consist of such details as friction take-ups, hand brakes, &c. The steam consumption in spreaders using mild steel heating plates varies from 0.54 lb. to 0.75 lb. of steam per hour per square foot of plate area. Assuming the shop temperature to be 72 deg. Fah. to 80 deg. Fah., and steam pressure 5 lb.–7 lb., it follows that waste steam from vulcanising presses can be used for this purpose.

Solvent Recovery from Spreaders.—A considerable number of attempts have been made during the last decade to recover the solvent evaporated from spreaders, but none can be regarded as final. The chief difficulty in recovering solvent from spreaders is the very low concentration of the vapour, and from this point of view an absorption process with charcoal or silica, treating either air drawn direct from these machines, or from the general atmosphere of the shop, should have distinct advantages. A recovery of about 90 per cent. of the solvent from very low concentration should be quite practicable. The disadvantages of almost all the types proposed up to the present are serious :—(1) The machines use air and are liable to fire. (2) Coverings prevent accessibility to cloth. (3) A number of small recovery units is not desirable. (4) It is advisable to carry on the recovery outside the spreading room, if possible. (5) Any system relying on cooling alone must of necessity give low returns. Air at 80 deg. Fah. will hold 13.5 per cent. by volume of benzol, and this will not condense unless a lower temperature can be obtained, which requires a large cooling apparatus. (6) In order to keep the concentration of solvent vapour as high as possible, air leaks must be eliminated and the air used passed as slowly as possible through the machine. This slows up the drying operation and, therefore, reduces output.

Calendering.—Frictioning and skim coating rubber or canvas or fabric requires the material to be dry and warm, a steam-heated drum being used for this purpose. The latest type is the cell drier, a very efficient plant composed of steam-heated chests, a useful addition here being the Foxwell guide for ensuring square batching on the box roller. Frictioning consists of passing the cotton material through a three bowl calender, the centre bowl of which is travelling faster than the top or bottom. Rubber is fed in between top and middle bowl, the different speed of the rolls forcing the rubber through the cotton material. Few improvements are noted in the design and operation of the calender, advances being chiefly in size of machine. The size used is up to 90in. in width, with variable speed from one yard up to 60 yards per minute. The elevating and lowering of the top and bottom rolls to control the gauge of rubber and finished material, is operated on the latest types of calender by small subsidiary motors, controlled by the calender man, an operation which was previously done laboriously by hand. Cutting pieces out and testing with a micrometer gauge is the usual practice. What is required is a gauge accurate to $^1/_{100}$ mm., indicating during the actual calendering operation. Several types of gauges for measuring thickness of material are manufactured, but none sufficiently accurate to be of real use. No satisfactory cloth tensioning device to act automatically is yet obtainable; most machines are provided with ordinary hand-operated band-brakes, and the manufacturer is left to depend on the skill of calender operators.

Topping calenders differ from frictioning calenders in that all three rolls are driven at the same speed, and topping is usually a separate operation. In America attempts have been made with some success to friction and top the materials in series. This, however, must be full of complication, and from the point of view of scrap, &c., it is probably profitable to split the operation.

Extruding or Forcing Machines.—These machines are used to force certain rubber compounds through dies, in order to obtain exact profile shapes. The extruded rubber is uncured, but must be worked to very definite limits. Extruding machines are used for manufacturing light and heavy tubes for various purposes, laying on layers of rubber to cables, belts, &c., and extruding strip and block from light and thin sections to heavy and square sections of any desired profile. There is much to be discovered by engineers as to what governs the correct extrusion of rubber. The chief difficulty in all rubber work is to keep the conditions constant. All water supplied to the cylinder and screw should be controlled, and suitable means supplied for observing temperature. The die should be steam-heated or preferably electrically heated, and a thermometer pocket provided in the die. The screw must be efficiently cooled. The screw is of heavy dimensions, and means must be provided for taking the thrust; the Michell thrust-bearing has given much satisfaction.

The temperature of extruded rubber is about 80 deg. Cent.; at this temperature the rubber is very easily stretched or distorted, so if it is extruded to exact limits it is necessary to cool it in order that the section shape may not change, and that the shrinkage may be on definite lines, giving a uniform result at the finish. To obtain this result, strip stock is often cooled by arranging to give the "take away" belt a long travel. Other schemes take it through a water trough, or run a copper gauze close woven belt which is water-cooled on its return travel. This is found sufficient to cool the rubber, but the common method is to batch the strip into linings on drums, and air cool, and it is then necessary to provide a definite "take-off" gear which will feed the drums with constant speed and tension.

Tubes are extruded through a special die with a centre, and it is obvious that the rubber will stick together on the inside unless special precautions are taken. An opening is provided for powdered chalk, which passes through the die-box to the centre of the tubing being extruded, and so coats it with chalk, preventing sticking.

Cooling of heavy extruded sections is even more vital, and special conveying plant must be devised, to enable the extruded stock to be tipped into an automatic conveyor, which, in some cases, travels a distance of 60ft. under water, the stock being automatically tipped on to a cutting table after rising above the surface. If some means could be devised for cooling the stock immediately it leaves the die, a big advance on present-day methods would be the result. The speed of extrusion, and the slow rate that rubber gives up heat, are factors that make the problem difficult. Hydraulicly extruding stock has been experimentally attempted, but the lack of continuous flow has not allowed its adoption.

Vulcanisation Plant.—There are three main types of plant :—

Open cure, in which the vulcanising heat is obtained from hot plates, and the necessary pressure on the moulds provided by bolts or hydraulic pressure. The ventilation in and around the presses must be such as not to affect the work and produce difference of temperatures. Bad work is often produced on this class of plant by windows or doors adjacent to the presses being opened, most of the cures in this type of press being effected in two to six minutes, and subjected to the temperature of steam at pressures from 20 lb. to 60 lb. per square inch. Effective insulation of all parts must be taken in hand and as few convection currents as possible allowed, which must have a definite direction to create sufficient cooling and a feeling of comfort to the workers.

Open-pan cure, in which the articles are placed in a steam pan in bolted moulds, or wrapped in position on half moulds or mandrels. Most open curing pans are horizontal, but the nature of the product settles this as in the case of very heavy wheel material, they must be vertical, but goods cured on carriages can be placed in pans set horizontally. The draining of the pan, the inlet and outlet of the steam, the door fastening and joints, are points requiring minute attention. In all steam-curing pans, whether of the open curing or autoclave type, an even temperature must be sustained and excess-heat pockets and air-pockets eliminated; if drenching or flooding is necessary the water must be drained away quickly and effectively, and a dry pan be ready for the next cure. By arrangement of the inlet pipes and the vent pipe, an even temperature can be obtained. As sulphur is the chief curing ingredient and is used in as high a percentage as 20 per cent., the piping and valves are attacked and a high renewal bill has to be faced unless care is exercised in the placing of valves. Process steam from a vulcaniser using high sulphur mix, cannot be returned to a low-pressure heating main.

Hydraulic Curing Pan or Autoclave.—Here the steam pan is supplied with a hydraulic press, which keeps the moulds closed during cure, high-pressure steam being used during cure and low for discharging the moulds from the pan. The shell of the steam vessel presents no particular engineering feature except that it must be made to withstand the expansion and contraction stresses set up by the operation of steam curing for one and a-half hours at 40 lb. to 60 lb., and the cooling down to a temperature of 80 deg. Fah. by the sudden flooding of the pans with cold water. If the riveted joints and seams are not of first-class manufacture there will be continual trouble due to leakage. These pans are often subjected to this heating and cooling every 30 minutes, and rarely less than 90 minutes. It is necessary to arrange the piping so that no steam can be put on with the hydraulic pressure off, or should the hydraulic pressure fail, warning is instantly given. Some plants are fitted with a locomotive whistle, which is kept closed by the water circuit; if by error or accident the pressure fails, there is an instant notification.

A single press will be operated 600 times in a twenty-hour day, not allowing for a false move. The hydraulic operating valves must be so designed that high pressure can only be used by passing through the low pressure position full on. This safeguards the supply being wasted. All joints and glands must be of the best design and workmanship, as a failure of pressure during cure can easily mean a loss of anything up £300 per pan.

Vulcanisation with External and Internal Pressure.—Patents have been taken out which provide special steam-jacketed moulds capable of taking a range of sizes and patterns, which can be securely bolted together and the internal pressure applied. This new method of curing would indicate very distinct advantages as far as reduction in necessary capital, operating charges, easy inspection, and handling are concerned. Two methods are in vogue for filling the moulds with gas for internal pressure; one is to make the connection out of the pan and inflate to final pressure, and the other is to have a system of connections, and inflate after the pan-lid is closed maintaining the pressure from the main.

Public Electricity Supply.

At the anniversary meeting of the King's College Engineering Society, Mr. C. H. Wordingham recently delivered an interesting address on "The Development of the Public Supply of Electrical Energy in Great Britain." After covering a good deal of historical ground, the lecturer showed how the diversity of the load met with in the various zones of a large town might substantially improve the load factor on a single station supplying the same load, but the mere stringing together of a number of precisely similar towns, all having the same characteristics of load, would not, it was explained, yield an appreciable diversity. The load factor under the latter conditions would not be appreciably improved, and the only advantage that would accrue would be the increased scale of operation.

The term bulk supply, Mr. Wordingham explained, was really a misnomer, for whatever means were adopted for generating the energy supplied to a given district the current had to be produced from moment to moment as required, the rate of generation corresponding exactly to the rate of consumption. The introduction of a line of demarcation between the generating authority and the authority which distributed the energy was purely artificial and did not in any way alter the conditions. The case was in no way analogous to the supply of gas or water, which could be delivered in bulk and stored for distribution when required. Practically the whole of the country was, in the course of a few years, divided up into large areas, each under the jurisdiction of a power company, and no doubt the parliamentary Committees which passed the power companies' Bills thought that an electrical millennium would ensue. Much of the evidence given before those Committees was entirely misleading. The emphatic distinction between the power and lighting loads which was drawn implied that there was some magic in the use of electrical energy for power which put it on an entirely different footing from its use for lighting. As a matter of fact, there were many power loads which had a poor load factor and many lighting loads which had an extremely good one. It was all a question of the number of hours per day that the service was required. In dealing with London, for example, cheap electrical energy for power was held up as a vital necessity, and the question of lighting pooh-poohed. Cheap energy for lighting was, however, if anything, the more important of the two in the Metropolis. Cheap lighting enabled dark premises which would be practically unusable with any other form of illuminant to be brought into service as efficiently as if they were illuminated by daylight.

In referring to the work of the Electricity Commissioners, Mr. Wordingham said that all the areas so far delineated by the Commissioners had been large ones; but it did not follow that the schemes for dealing with the complete area necessarily provided for the supply of energy to every part of the area. Still less did it follow that the supply would necessarily be given from a single capital station or even from a few such stations. Whilst the Commissioners were undoubtedly strongly impressed with the advantages of concentration of plant and transmission over long distances, they were by no means tied to these ideas, and were quite open to conviction that other schemes might in certain cases be desirable. In a number of areas there were portions or individual towns which were so isolated that even though the cost of generation might be considerably higher than in a capital station, it would be cheaper to employ a local station than to transmit the cheaply produced energy over long distances. In such cases the isolated town or area would be allowed to have its own relatively small station.

There could be little doubt that there would be a number of capital stations established, either as entirely new ones or as the development of existing efficient stations, and many authorities generating their energy on a small scale would ultimately cease to do so and take their supplies in bulk. Economy was sure to be effected in many instances by that course, and a number of districts would have the advantages of an electricity supply for which they would otherwise have to pay a high price or go without. It was not to be imagined, however, that in every case a bulk supply would be cheapest. It was to be remembered that the real matter of importance was the cost of the unit delivered to the consumer. It might be assumed that the cost of distribution within the local area would be practically the same, whatever the source of the energy distributed, and in most cases the distribution would involve a substantial sum per unit for distribution alone, and that sum had to be added to the cost of the energy delivered in bulk or generated locally. The price of the energy delivered to the distributing authority was made up of the cost of generation, per unit sent out from the capital station, and the cost of the transmission from that capital station to the area in which the energy was distributed, and it was obviously no use to have cheap generation if the transmission costs increased the price to a value in excess of that involved in generating the current locally. It would be found in a number of cases in which transmission costs had to be taken into account that a bulk supply would actually be more costly than a supply provided locally with small expensive and relatively inefficient plant, and in spite of those drawbacks the small station was then preferable.

In concluding his address, Mr. Wordingham remarked that it was quite conceivable that present methods of generation would be radically altered. Three-phase alternating current necessarily involved many difficulties and complications, and some engineers saw great possibilities in the simpler and at all events temporarily discredited single-phase alternating-current system, whilst others would not exclude extra high-pressure direct current.

THE CONTROL OF THE SPEED AND POWER FACTOR OF INDUCTION MOTORS.

The first of a series of four lectures on "The Control of the Speed and Power Factor of Induction Motors," was delivered by Professor Miles Walker at the Institution of Electrical Engineers on Wednesday, February 21st. The object of these lectures is to supplement the lectures on alternating-current machinery given in the various colleges in London, and the first of the series was devoted to the principle and application of inversion in connection with alternating-current calculations. Many induction motor problems, the lecturer explained, could be tackled most easily by employing the principle of inversion as introduced by Bragstad, and dealt with in the book on "The Theory and Calculation of Electric Circuits," by J. L. La Cour and O. S. Bragstad, translated by Dr. S. P. Smith. The third-year student, Professor Miles Walker pointed out, can generally draw the cycle diagram with facility from no-load test figures, and deduct the various quantities which are so easily determined from it, but he can hardly be expected to construct a diagram from first principles in those cases in which special apparatus, such as a phase advancer, is in circuit with the rotor. There seems to be no doubt that this principle of inversion, when properly mastered, is of considerable value to students and electrical designers. The lectures, we understand, are to be published in the columns of our contemporary, the *Electrician*, and subsequently in book form.

The electrification of the Swiss State Railways will, it is believed, be finished by 1928, i.e., five years earlier than was estimated in the scheme which was drafted in 1918. The electric system will cover 950 miles, and involve the use of 400 electric locomotives.

A Seven-Day Journal.

The Proposed Humber Tunnel.

ADVOCATES of the construction of a tunnel below the Humber in the neighbourhood of Hull have received powerful support from Professor P. F. Kendall, the occupant of the chair of geology at Leeds University. Speaking at Hull on Monday, he said that Hull was on the wrong side of the river so far as the Yorkshire, Derbyshire and Nottinghamshire coalfields were concerned, and that a tunnel below the Humber would, as a consequence, be of great national importance. As regarded the engineering aspects of the work, he drew attention to the fact that the chalk in the bed of the Humber was harder and contained much more water than the southern chalk which would be encountered in making a tunnel below the English Channel, and that the work would be proportionately more difficult to execute. Below the chalk, however, lay clay in which a tunnel could easily be driven, except in so far as care would require to be exercised in order to avoid trouble arising from the piercing of a deep deposit of glacier sands and gravel. The scheme was, he held, quite practicable from an engineering and geological point of view, but whether it would be financially successful he was not in a position to say. The Hull authorities are greatly interested in the matter, and are wholeheartedly in favour of it. They are looking to the Government rather than to the railways to assist them, for it is recognised that as the railways live by mileage, they will not view with favour a costly scheme which will shorten the distance between Hull and London by 18 miles.

Two New Aero Engines.

AT the recent Air Conference Sir W. G. H. Salmond referred to experiments which were in progress with an inverted form of the Napier "Lion" 450 horse-power engine. We understand that after great mechanical difficulties had been surmounted, particularly in connection with the attainment of proper lubrication, the engine was successfully tested on Monday at the Napier Works at Acton, and that it developed the full horse-power of the parent engine. The object of the inversion is to improve the pilot's forward view and to enable the exhaust gases to be lead away in an improved manner. At the opposite end of the scale news is to hand regarding the successful test of a very small aero engine—the Bristol Aeroplane Company's "Cherub," designed to develop only 18 horse-power. The engine has two parallel opposed cylinders, and weighs about 85 lb. It opens up new possibilities in the practice of gliding, for by its use it should be possible to construct a machine on glider lines which will be able to sail over considerable lengths by the switching on of the engine when the wind currents would otherwise fail to support the machine in the air.

Placing Public Contracts Abroad.

FOLLOWING the lead of other associations the British Empire Producers' Organisation has been laying its views before the Government on the question of public bodies and Government departments placing contracts abroad. On Friday of last week a deputation laid the Organisation's views before the Board of Trade. It was suggested that all contracts placed by public bodies, Government or local, should be given only to British Empire firms employing British Empire materials and labour, except licence to do otherwise were given by a committee set up for the purpose and representative of the spending departments and organised industry and labour. It was urged that legislation should be enacted to make such procedure compulsory, and that in the meantime Government departments should put the principle into practice without waiting for an Act of Parliament. Replying for the President of the Board of Trade, Sir William Joynson-Hicks said that the Government was in full sympathy with the object which the deputation had in view, for it was regarded as one of great and immediate importance. The matter had been receiving the Government's careful attention for some time, particularly that of the Cabinet Committee on Unemployment.

The Mid-Lancashire Electricity Scheme.

AT the Electricity Commissioners' inquiry at Preston on Monday it was announced that all the parties concerned had reached an agreement regarding the supply of electricity in the Mid and East Lancashire area. The Committee to be appointed as a result of the agreement is to give effect to the scheme of reorganisation arrived at within a period of two years. Under the scheme three stations—namely, those at Bispham and Blackburn (Jubilee-street) and that of the Blackpool and Fleetwood Tramways—are to be closed down immediately, while those at Preston (Crown-street) and Deepdale are to be closed as soon as the Ribble station is in operation. The stations at Colne, Darwen and St. Annes are not to be extended, and a new station is to be erected, when required, in the neighbourhood of Burnley, either by the Corporation of that town or by the Lancashire Electrical Power Company. The scheme also involves the laying of a considerable amount of new main transmission lines.

The Post-office Telephones.

ACCORDING to a statement made this week by the Secretary in charge of the Telephone Branch of the Post Office, the past year saw a considerable development of the country's telephone system, particularly in the rural areas, and an increase in the efficiency of the services provided. At the end of the year the total number of telephones in the Post Office service was 1,028,258, of which 370,000 odd were connected to London exchanges, the remainder being in the provinces. The month of January saw a further increase of 5800 telephones. The number of urban exchanges is now 1459, and of those in rural districts 1681. A considerable number of additional rural exchanges will be opened this year and in other ways such as by the adoption of a system of special party lines, for which cheap rates are charged, the Post Office telephone department is seeking to render assistance to the agricultural community. The new "toll" system, the Secretary stated, is fully satisfactory, the service between London and all places within the toll area having been accelerated. In particular, between London and Brighton the services in both directions is now comparable with the London local service.

The British Corporation and Oil Ship Construction.

AT the thirty-third annual meeting of the British Corporation for the Survey and Registry of Shipping, held at Glasgow last week, the chairman, Mr. Robert Clark, referred to the patent rights held by the Corporation for the "F.K." or "Montgomerie Macmillan" system of oil ship construction. A year ago he said they were threatened with an action for the reduction of the patent. Further experience and consideration had convinced them of the validity of the patent, but they were none the less glad that the contemplated action had been withdrawn. On the question of the propriety of a public body such as theirs holding patent rights of a commercial value, he remarked that there was greater room for argument as to the wisdom of placing improvements of such public utility in private hands. They had agreed that Lloyd's Register should grant approval to the plans of ships to be built under the system, were prepared to grant similar facilities to other classification societies, and were willing to give free advice and assistance to all designers using the system, whether the vessels were to be classified with the corporation or not. It could not, therefore, be said that their holding of the patent acted to the restraint of trade or constituted an entry into commerce. Vessels built under the system and surveyed by the Corporation had so far proved very satisfactory in service, and had, he said, confirmed shipbuilders in their favourable opinion of the method of construction.

The Endowment of Research Workers.

THE British Science Guild was founded in 1905 with the object of convincing the British people of the necessity of applying the methods of science to all branches of human endeavour, and thus to further the progress and increase the welfare of the Empire. It has been responsible for two interesting exhibitions of scientific products, and is now making increasing efforts to stimulate the scientific spirit in industry, commerce and all fields of human activity. In furtherance of that object it held a meeting at the Mansion House, London, under the presidency of the Lord Mayor, on Tuesday. Lord Askwith, the President of the Guild, urged that we might do a great deal more than we are doing at present to endow discovery, for it was of immense importance that men without hope of reward should be able to work at the probing of Nature's mysteries. Sir Ronald Ross, pleading for more money for research work, said that we were devoting only about £250,000 a year to scientific investigations, whereas in America three or four times that amount was being spent. Those who were engaged in solving great scientific problems should, he held, be given pensions in order that they might be able to devote their whole energy to their work.

Overtime in Shipyards.

AN agreement as to national rates of pay for overtime in shipyards has been reached between the Shipbuilding Employers' Federation and the Engineering and Shipbuilding Trades' Federation, and has been submitted to a ballot of the men, the papers to be returnable by March 20th. We understand that the provisional arrangement that only in real emergency shall employers call upon men to work more than thirty hours' overtime in four weeks still holds, and that the agreement is strictly limited to rates of pay. It provides that day workers shall receive 50 per cent. above their ordinary rates, and piece workers 25 per cent. upon their average hourly earnings. For Sunday work these rates are doubled, whilst on certain holidays double rates are to be paid to both time workers and piece workers, and on other holidays rate and a-half is to be paid all round. On night-shifts 33⅓ extra will be paid, and on overtime night shift time workers will take twice this amount and piece workers an additional 25 per cent. The agreement is to hold for three years, at the end of which time it is to be terminable by either side at six months' notice. The vote on this agreement will be pooled.

The Hoffmann Manufacturing Company.

WE understand that the Government is prepared to receive offers for the purchase outright of its entire holding of shares in the Hoffmann Manufacturing Company. The Hoffmann Company's works at Chelmsford produce anti-friction bearings of all kinds, and were acquired during the war by the Government at a cost of over £1,000,000. Considerable sums were subsequently expended on effecting extensions. Inquiries in connection with the matter should be addressed to the Treasury Solicitor, Storey's gate, S.W. 1.

Miners' Wages.

THE Prime Minister met a deputation of coal miners in December last and listened to a request for an inquiry into the industry and the methods of production and distribution. There were indications of improving trade at that time, and anticipating that the lot of the miners would improve, Mr. Bonar Law refused the request but agreed to meet the deputation again in a few months. In fulfilment of that promise, he received a deputation on the 27th inst., and again found himself called upon to refuse the inquiry. It was not contended that the condition of miners is satisfactory, and although increases affecting 700,000 men have been made in certain districts, in others the weekly wages remain at the minimum, but in his reply the Prime Minister was able to present figures which showed an improvement both in wages and volume of coal production, and indicated the existence of a better economic position. On their side, the miners' representatives asserted that the increase of wages during the past three months did not amount to more than sixpence per day, and did not raise those who received them above the poverty line. We understand that in view of the Government's refusal to institute an inquiry, a national conference has been called by the Miners' Executive.

Sixty Years Ago.

IN his speech on the Navy Estimates, according to some notes in our issue of February 27th, 1863, Lord Clarence Paget reported that the Admiralty was in a position to obtain good armour plates, both hammered and rolled, but that it found the rolled plates more uniform. Mr. Brown, "a gentleman distinguished by great zeal and conducting important works at Sheffield," had, he said, been most successful in producing plates. The question of annealing the plates apparently gave rise to doubt. Indeed, it was reported that no apparent difference was noted between the annealed and unannealed plates, and that the Admiralty was in complete uncertainty as to the results produced by different processes. In the same speech Lord Clarence Paget referred to an invention of Captain Coles, which he, the speaker, believed would produce a great reform in the masting of vessels. The system consisted of having an iron cylinder for the mast supported by two other cylinders. "This system," Lord Clarence remarked, "has not been tried yet, but I mention the matter in order to show that we are anxious to take advantage of every invention." Actually the tripod mast was not adopted, we believe, until Sir Philip Watts designed the Dreadnought. In our correspondence columns appeared a letter signed "V. Pendred," which was one of the earliest, if not the earliest, contributions to our columns of the gentleman who succeeded in a few years time to the editorship of this journal. His subject was colliery locomotives, and in particular a 2ft. 6in. gauge engine, recently built by Mr. Smith, of Coven, near Wolverhampton, to haul coal and ironstone to the Willenhall furnaces over tortuous lines about a mile in average length. The work previously had been performed by a large number of horses, and the deductions drawn from the success attending this experimental engine was that there were few situations in which small locomotives could not be employed with advantage as a substitute for animal power.

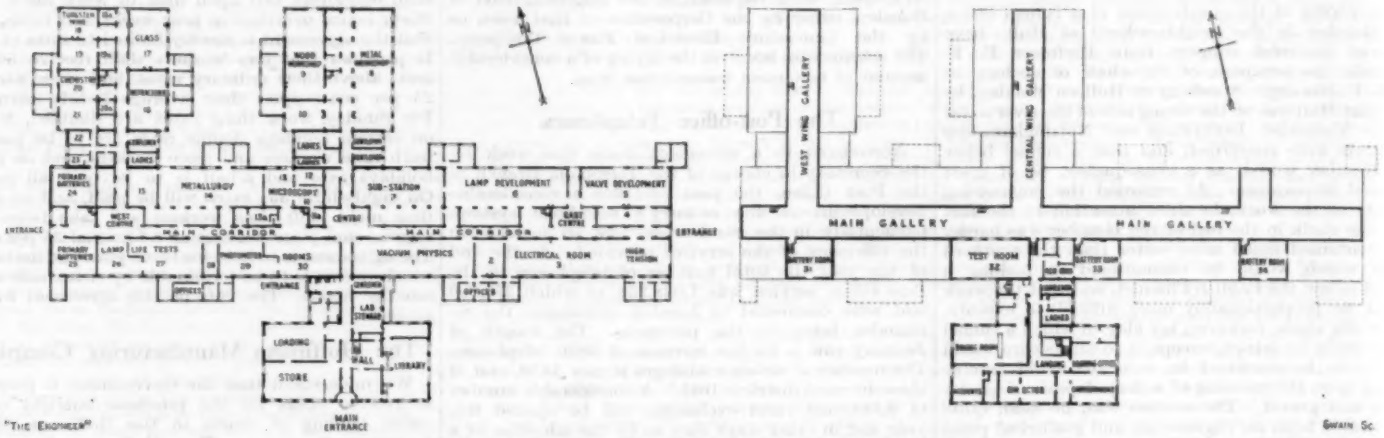
Research Laboratories at Wembley.

THERE is ample room in the electrical industry for the development of new manufacturing processes, and the more economical use of materials. Although electrical machines and appliances have been vastly improved since electricity first came into use, no one imagines that the state of finality has been reached and that nothing remains to be discovered. Research may easily lead within the course of a few years to a radical change in existing ideas, and to drastic alterations in the construction of electrical machinery and appliances. Hitherto the electrical manufacturers in this country have not, on the whole, paid sufficient attention to research, notwithstanding that some of their products might very well be improved. Take railway equipment, for example. Few fail to recognise that the proposal to adopt a standard pressure of 1500 volts—which is much too low for main line work—is due to the fact that rotary converters cannot very well be built for higher pressures, and it has been left to a Swiss firm to investigate the possibilities of the power rectifier. There has long been far too great a tendency to adhere to standard practice and to neglect research.

It is true, of course, that experimental work on altogether new lines is not always profitable, but much depends upon the men who are entrusted with the work. The best research laboratories that money can provide are of little use in the absence of proper men to run them, and it is in this direction, we think, that research has often proved unsatisfactory to the manufacturer in the past. But given the right men and the proper experimental equipment, there is not much doubt that in the long run a research department will ultimately prove a boon to the electrical manufacturer. This, at any rate, is the conclusion that has been arrived at by the General Electric Company, which, on Tuesday of this week, formally opened at Wembley by far the most extensive and elaborate research laboratories that are connected with electrical manufacture in this country.

These laboratories, which have now been, more or less, in use for the past nine months, have been laid out with a view to enabling the research staff to make investigations in many different branches of science. There is to be no restriction as to the character of the problems attacked, or the method of dealing with them, although preference will naturally be given to those problems which seem to offer the best chance of yielding information of use to those branches of the industry in which the company is or may be interested. When the members of the laboratory staff are asked to investigate some manufacturing difficulty, they do not restrict their inquiries to the obvious avenues, but attempt to understand more fully than before the fundamental principles upon which this branch of manufacture is based. The line which the research follows depends quite as much on the interest taken in the work as it does on the practical problem which caused the research to be undertaken. It has been found in the past, and it will also no doubt be found in the future, that a research started in the hope of solving a certain problem, has ended in solving another problem which was not taken into consideration at the outset. Although most of the problems that have to be dealt with arise from the manufacture of electrical appliances, it does not follow that the research work can be confined to the practice of those branches of science which appear most intimately connected with these appliances. Lamp research, for instance, is not confined to work in vacuum physics, but is equally concerned with metallurgical research, glass research, radiation from solids and gases, high tension electric phenomena, and chemistry, particularly reactions at very high temperatures.

The laboratories under consideration are situated close to North Wembley Station on the extension on the Bakerloo Railway. In the construction of the main buildings no restrictions were imposed by shortage of ground, and it was, therefore, decided to adopt the "one floor" type of construction. Ease in carrying out extensions, good natural illumination, the ready handling of heavy pieces of apparatus, and the harmonising of the building with its surroundings, were the main factors which led the company to erect a structure of this type. The main building has a frontage of 400ft. and a total floor area of 80,000 square feet, the area of the enclosure being four acres. A plan of the main building is given in Fig. 1 and a cross-section of the laboratories in Fig. 3. For the most part the "Weaver" type of north light roof has been adopted, and, as will be seen from the plan, the building consists of one long block running east and west, with central and west wings running north, but the east wing has not yet been built. A two-storey central extension to the south forms the administration section. This form of construction enables the building to be extended at five different points, so that in future additional accommodation for further research work can be provided without disorganising the existing scheme of internal laboratory arrangements. There are nine small groups of rooms built out as private offices from the main laboratories, and arranged so that there is direct access from every laboratory to one or other of the groups of offices, with the result that each member of the research staff has an office near his work. Care was taken in the design of the building to provide ample accommodation and flexibility for the electrical and other services, such as gas, vacuum, compressed air, &c., for it is essential in experimental work to ensure that those services are available at all points of the rooms. Ample and well-lighted storage for lumber and apparatus that is not always in use is also important, for otherwise the laboratories become congested with a quantity of gear which is not constantly required, and it will be seen from Fig. 3 that between the main laboratories on each side of the building there is a centre bay, which runs the whole length of the building, and that this contains a corridor on the ground floor, while above the corridor there is a gallery, along the whole length of which run the pipe services and also the cables for the various electric supplies. This gallery also serves to accommodate the lumber and bulky apparatus which is not in use, and also all the general service apparatus, such as compressed air reservoirs, gas and water containers, hot water apparatus, motors, driving shafting, and all those things for which it is difficult to find accommodation in a laboratory, and which are not wanted in the experimental rooms themselves. In the space under the central gallery to the right of the corridor there are photographic dark rooms, store rooms, and compartments for housing noisy machinery. This space can, however, be made to form part of the laboratory



FIGS. 1 AND 2—GROUND AND FIRST FLOOR PLANS OF THE LABORATORIES

FIG. 4—THE CHEMICAL LABORATORY

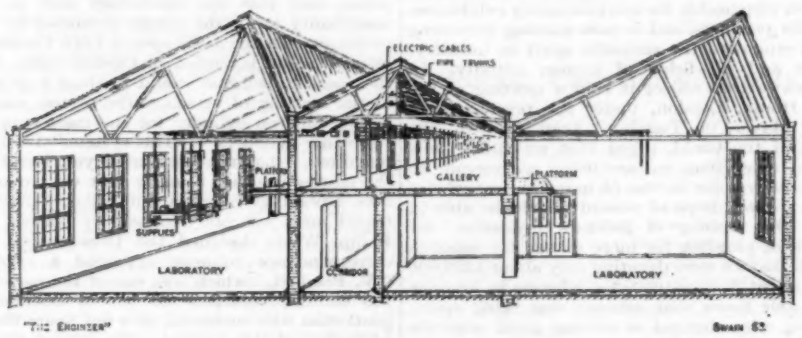


FIG. 3—CROSS SECTION THROUGH LABORATORIES

itself, and may be used for work which requires a subdued light. By this arrangement one of the chief drawbacks of the north light building has been overcome, namely, the difficulty of obtaining certain small subsidiary areas which are needed for special purposes. The gallery floor has been extended into the laboratories to form a platform in each room to accommodate high tension apparatus or other gear which should be placed out of reach of those on the floors on which the work is being carried out. A plan of the first floor of the laboratories is shown in Fig. 2, whilst Figs. 4, 5 and 6 show the chemical laboratory, the metal working shop, and the lamp testing room. The illustrations—Figs. 7–10 on page 232—show the experimental lamp factory, the experimental tungsten wire factory, the experimental valve factory, and the vacuum physics laboratory respectively.

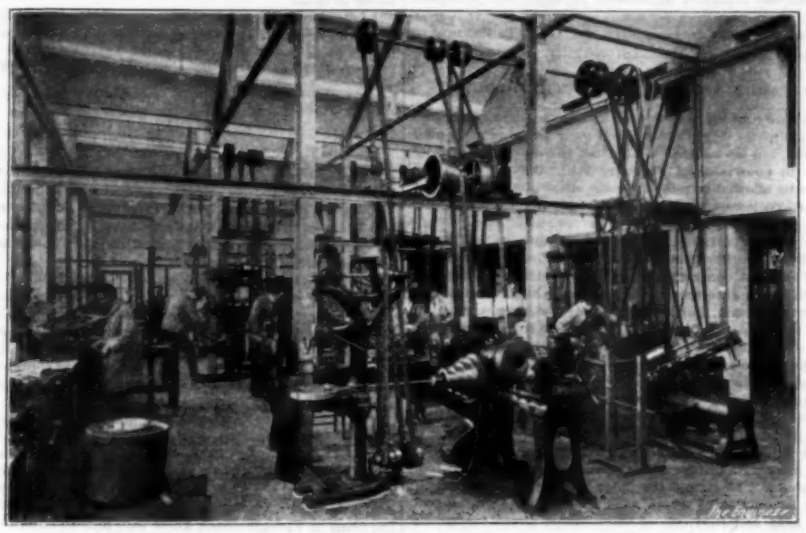


FIG. 5—THE METAL WORK SHOP

As shown in the plan—Fig. 2—three battery rooms adjoin the gallery, and are situated over three of the experimental rooms. The administration block of the building is an ordinary two-storey structure, with a reinforced concrete floor, and contains the hall and waiting room, stores and packing rooms, correspondence and other offices, and the research staff refectory. On account of the excellent natural lighting of the buildings, the importance of good artificial lighting in the experimental rooms is less pronounced than usual. In the north-lighted rooms the sloping ceilings are of smooth whitened plaster slabs, the reflecting surfaces of which being used for spreading general diffused light from open high candle-power frosted lighting units placed well up in the ceilings.

FIG. 6—THE LAMP-LIFE TESTING ROOM

Besides the special apparatus in the individual rooms, there are electric gas, vacuum, compressed air, water, and hydrogen mains working under different pressures, suitable for different requirements. Three main vacuum pumps, which supply the "fine," "rough," and "general" vacuum mains, are placed in the central sub-station, together with the electrical machinery. The air compressor plant comprises two rotary type compressors, which deliver into a receiver having a capacity of 250 cubic feet, and the compressors are fitted with automatic control gear. For the supply of hydrogen, which is needed mainly for reducing processes in the preparation of tungsten powder, but which can be made available in any part of the building, a special gas holder has been provided, which has to be filled from cylinders of compressed gas. The usual method of making any of the above supplies available in any laboratory is to bring the pipe down at the centre of the room to within 6ft. 6in. of the floor. Two gas and two compressed air pipes come down at the four corners of a rectangle, which measures 6ft. by 3ft., and at the lower ends there is a timber framework which forms a kind of cradle on which all the various supplies—gas, water, electric, &c.—terminate, and connections are easily made from the pipes and cables so that the supplies can be made available at the experimental tables and benches.

Two electric ring mains run round the walls of every room, one giving a 110 volt alternating current supply, and the other a direct-current supply at the same pressure. These mains terminate at plug points on the wall, and also on the cradles previously referred to. In a building of this size central control of the electric supplies and circuits for experimental work would be inefficient and cumbersome, and three main control points are, therefore, provided, with seven distribution boards for the experimental electric circuits used by the research workers. These points are at the three junctions of the three wing corridors, where there are switchboards which enable any of the different sources of electric supply to be connected through to any laboratory. In this way no fewer than fourteen alternating and direct-current supplies are provided at many pressures. If larger currents or higher voltages than those given by these supplies should be needed, special arrangements would be made at the points where these voltages and currents would be used.

The main workshops are for making special apparatus required for research and the general equipment of the laboratories, and also for investigating production processes. There are two of these workshops, one being the wood and the other the metal workshop—which is shown in Fig. 5. There are also four small experimental factories for making lamps, tungsten wire, thermionic valves, and primary batteries. Raw materials or, when convenient, partly manufactured parts, are drawn from the works and kept in store at the laboratories, for the experimental factories to work upon. If of stock pattern the finished product is returned to the works and added to their manufactured product for sale, but the total output from the laboratory workshops is small. Moreover, an appreciable part of the output may, of course, be non-standard as the result of the introduction of new innovations, and goods of this kind are subjected to special tests. Arrangements have been made in certain cases for the routine testing. At the present time lamps and valves are the chief factory products which are subjected to those tests, but primary batteries are also tested in this way. Care is, however, taken to see that this work does not interfere with research, and each routine department has a steward who is directly responsible for the work.

MINING DIATOMACEOUS EARTH IN CALIFORNIA.

A LARGE deposit of diatomaceous earth or kieselguhr is mined near Lompoc, California; it covers several square miles and ranges up to 700ft. thick. The bed contains many folds, but was apparently laid down horizontally at the bottom of a fresh-water Miocene sea. Kieselguhr consists of the siliceous skeletons of diatoms, of which over 2000 varieties have been identified at Lompoc. According to the technical director of the company, three varieties, *cascinodiscus robustus*, *cascinodiscus oculus iridis*, and *cascinodiscus woodworii* predominate, of which the first-named has the greatest economic value. The deposit is owned and worked by the Celite Products Company. The company has a mill for treating a part of the product at Lompoc, which is about 4 miles from the quarries. At the present rate of production the supply should last for several centuries.

The principal uses of the kieselguhr are:—(1) Sawed brick for refractory purposes; (2) compressed refractory brick, which in quality is between the sawed brick and ordinary fire-brick; (3) ground product, used as filtering material at sugar mills; (4) light-weight filler in concrete, used instead of rock aggregate in some Government work; (5) insulation purposes; (6) automobile polish, silver polish, diluting talcum powder, &c.; (7) nitro-glycerine absorbent in some grades of dynamite. The character of the material varies in different parts of the bed and only selected parts where the overburden is light are quarried. Also certain parts of the bed are used for specific purposes. After cleaning off the overburden the diatomaceous earth is quarried by means of a channelling machine developed by the company. Cuts are made across the face 4ft. deep and 4ft. apart. The largest part of the production is used for insulating bricks, which are sawed on the ground from the blocks cut by the channelling machines. The machine used for sawing the brick was also developed by the company. The material desired for grinding is quarried, after channelling, by pick and shovel and loaded by hand into horse-drawn wagons and then hauled to a drying yard. The bricks are hauled to a drying yard in light tramcars. After sun drying the bricks are hauled to the railway and the other product to the mill in motor trucks.

At the mill the sun-dried diatomaceous earth is fed by hand into an impact pulveriser, which is moved along the bottom of the storage bin. The pulverised material is drawn through galvanised iron tubing by an exhaust fan to the main building, where it is packed for shipment in bags. Unbroken single diatoms are desired for filtering and some other uses. The dust, consisting of the finer particles and broken diatoms, which does not settle in the bins of the main building, is drawn into a bag house, where it is filtered out of the air. This material is used for polishes and other similar purposes. All crushing is done dry. The kieselguhr is nearly pure silica and has the capacity of absorbing several times its weight of liquids. Dr. Herbert Insley, petrologist, United States Bureau of Mines, examined some of the samples under the microscope and made the following report:—The deposit is damp when first exposed, but during the summer months the air is very dry and the wind blows almost continuously, hence the surface is soon dried. Since the kieselguhr is very light, the dust is easily picked up by the wind.

SOUTH AMERICAN RAILWAY NOTES.

THE administration of the Argentine State Railways has decided to convert from coal to oil fuel the whole of the locomotives used upon the Guemes, La Quiáca, and Salta routes, as well as the expresses between Salta and Tucumán, preliminary experiments carried out with four locomotives between Córdoba and Cruz-del-Eje having proved successful.

Construction on the Yungas-Pará-Beni Railway in Bolivia has proceeded with such rapidity that work has been completed as far as Vegas Yungas.

Satisfactory progress is being made upon the construction of the branch line of the Puerto Alegre and Uruguayan Railway, the object of which is to connect the cities of Alegrete and Quarahy. The new construction forms part of the State programme to link together a number of detached railways in different parts of the State so as to bring Puerto Alegre into easy connection with every part of the frontier, and ultimately into direct communication with the capital, Rio de Janeiro. This system is known as the Viacao Riograndense—New Rio Grandence Federal Railway system. The new line will connect at the frontier (Quarahy) with the Uruguayan North-Western Railway running from the Uruguay side—town of Sao Eugenio—to the Midland system. The original construction contract was given, as far back as February, 1911, to Messrs. Leivas, Reboucas and Garcez, who, in 1912, transferred the contract to the Empreza Constructadora de Rio Grande do Sul, which also undertook to construct the Basilio- Jaquaraoline—53 kiloms. in length—and the Sant' Anna-Sao Sebastiao line—169 kiloms. in length.

What is described as the longest concrete railway bridge yet constructed in South America has recently

been completed and opened to traffic in Chile. The construction, which has a length of 681 m., and which rests on forty-six piers from 12 to 15 m. in height, crosses the Maipo River, on the Paine-Talagante Railway. The construction is notable for the fact that none but national materials have been used.

A considerable amount of railway construction work is proceeding in Ecuador. Although activity has been interrupted by recent political upheavals, some progress has been made on the new railway between the port of Guayaquil and Santa Elena. Kilometre 6 was reached early in September. Kilometre 70 was expected to have been attained by the end of December, 1922, and, according to contract, kilometre 100 should be reached before the end of February next. Over 100 men are at present employed upon this part of the work, while contracts have been, or will be, made in connection with new construction or extensions upon the following lines:—Quito-Esmeraldas, Ambato-Curaraya, Sibambé-Cuenca, Bahía-Chone, San Juan Chico-Riobamba, Puerto Bolivar-Loja, and Monta-Santa Ana. Of these various undertakings the most important are the Guayaquil-Santa Elena and Sibambé-Cuenca—formerly known as the Huigra-Cuenca. The last named contract for constructing a railway from Sibambé, on the Guayaquil and Quito line, south 150 kiloms. to the city of Cuenca in Southern Ecuador, was originally granted to the German firm of Orenstein-Köppel-Arthur Köppel (Berlin), but was subsequently abandoned and taken over by Mr. E. H. Norton, President of the Guayaquil and Quito Railway Company.

Letters to the Editor.

(We do not hold ourselves responsible for the opinions of our correspondents.)

THE CYCLIC IRREGULARITY OF GAS ENGINES.

Sir,—I have just added Mr. Wimperis's interesting book to my shelves, and as a result I have a problem to solve as to which of two engineers is right. May I ask the assistance of The Engineer and its contributors?

Mr. Wimperis shows apparently—I cannot completely follow his mathematics—that if a be the cyclic variation, *i.e.*, $\frac{\text{max.} - \text{mean}}{\text{mean}}$ speed, then the arc of advance of the crank by which it leads the position due to mean speed equals $57.3 \div a$. Thus, for $a = 1/_{100}$, this lead is 0.28 deg.

In your issues April 17th and 24th, 1908, you publish a paper by Mr. Atkinson dealing with, amongst others, this very point.

Whilst Mr. Atkinson's method is perfectly clear and equally simple, the result is so totally different from that shown by Mr. Wimperis, that both cannot be correct, and, even allowing for the different rate of acceleration used by the two authors, one must be wrong in principle.

It may, I think, be taken for granted that the lead or lag of the crank is proportionate to the cyclic irregularity shown by the usual formula $\frac{\text{max.} - \text{min.}}{\text{mean}}$, and this letter is based on this assumption.

Mr. Wimperis on this being equal to $1/_{100}$, shows an arc of advance or lag = 0.28 deg., and by the foregoing assumption if a were $1/_{50}$ the advance or lag = $0.28 \times 4 = 1.12$ deg.

Now $a = 1/_{50}$ is practically that of the single-cylinder four-stroke engine taken as an example by Mr. Atkinson (Mr. A. = 49.95). Mr. Atkinson's angle of lead is, however, 1.8 deg.

An error of principle appears to me to be the cause of the difference, not to be accounted for by such questions as varying torque causing variation of rate of acceleration. Mr. Atkinson's method appears to be that of averaging the accelerations, positive and negative, over the four strokes of the cycle. This simplifies the calculation, but does it lead to correct results? It appears to me that it cannot do so, for the reason that the acceleration cycle does not coincide with the working cycle, the peak measured by angle of advance forming a hump at a different point on the torque curve to that assumed by the writer of the paper. Obviously, the minimum speed results when the fly-wheel has given up all the energy demanded by the three idle strokes, *i.e.*, at the ignition or "in" centre. It is equally obvious that the maximum speed results when the fly-wheel has received, *i.e.*, been empressed with energy beyond that demanded by the total resistance torque. Thus maximum speed may be considered as occurring at the end of the ignition stroke, and the maximum crank lead also occurring at this point. Thus, whilst acceleration occurs during 180 deg., negative acceleration occurs during 540 deg.

Thus, in the case taken by Mr. Atkinson, and assuming uniform acceleration during the impulse stroke, and taking $a = 1/_{50}$, then the total angle of acceleration of crank from the point on crank circle corresponding to minimum speed to the point corresponding to maximum speed is 180 deg. $\div$ 50 $\times$ 2.

Note.—Since the maximum change of speed above minimum speed is $1/_{50}$ of the mean speed, then since the mean change of speed is half the maximum, the factor 2 appears, and the mean change of angular position during the firing stroke is 180 deg. $\times$ $1/_{100}$. This is clearly stated by Mr. Atkinson.

But since we are not concerned with the total accelerated angle, but only by the lead or lag of the crank from its "mean" position, we introduce another factor 2—again shown by Mr. A. Thus the complete formula becomes 180 deg. $\div$ 50 $\times$ 2 $\times$ 2 = 0.9 deg. = lead or lag. This is just half the value given by Mr. Atkinson following his own general principle, but considering only the firing or impulse stroke instead of an average over two strokes, during one of which—exhaust—the engine must necessarily be absorbing energy and falling in speed and not receiving energy and rising in speed.

My figure of 0.9 deg. is not so very different from that—deduced—of Mr. Wimperis as it is from that of Mr. Atkinson. Which of us is right? We may all three be wrong, but we cannot all be right!

It may be as well to point out that the difference in the case of a large engine alternator represents a great deal of money. Whilst it is certainly possible to operate a power-house in parallel with engines having a large value of $\frac{\text{max.} - \text{min.}}{\text{mean}} = \frac{1}{n}$, the work is more difficult. All the engines must run at the same speed and have the same governing characteristics to enable the engines themselves to be paralleled as well as the electrical end; *e.g.*, an incoming machine would be connected only on the ignition stroke if, at the moment, the service engines were on the ignition stroke.

Thus such insertion of a new generator is even more troublesome, with a view to a good parallel, than in the case of some steam plants where it has been found necessary to have the connecting-rods on the same point of their cycle at the moment of closing the switches. It is desirable, therefore, when possible to limit the angular deviation to so small an amount as to be practically negligible.

If Mr. Atkinson is right in his method, he would need to spend nearly twice as much on his fly-wheel as Mr. Wimperis would estimate, and just twice as much as I should.

Note.—Mr. Wimperis takes as his basis line that of mean speed, *i.e.*, $a = \frac{\text{max.} - \text{mean}}{\text{mean}}$; Mr. Atkinson, the more usual $\frac{\text{max.} - \text{min.}}{\text{mean}}$. ∴ Strictly to compare the two methods, the figure (0.28) given by Mr. Wimperis should be doubled = 0.56. Further, if we take max. crank torque $\div$ mean crank torque = 1.59, and divide my result by this we have thus $\frac{0.9}{1.59} = 0.566$, by which we see complete agreement between Mr. Wimperis and myself.

Angmering, February 26th. Geo. T. Pardoe.

SAW GUARDS AND SAFETY CUTTER BLOCKS.

Sir,—Had we noticed earlier your article on these subjects—December 29th—we would have asked your permission to offer some remarks, but we see that H.M. Chief Inspector of Factories made reply in your issue of February 9th. We shall be glad, however, to be allowed to refer to some other points within the range of our experience, not only as saw mill engineers, but also as saw mill proprietors.

We note you suggest that to "enclose a circular saw below the table by metal screens is unnecessary." We remember, however, a sawdust contracting firm's boy getting his foot cut off by kicking down into the pit the sawdust which had accumulated under the bench, but, unfortunately, he caught with his leg the saw which was revolving. This leads us to the conclusion that such a safeguard would have saved that boy and might prevent other accidents, if adopted.

The article on the "Policy of the Safety Cutter Block," by a "Well-known Saw Mill Engineer," greatly surprised us. Doctors are said to differ; so surely engineers may, and we claim that privilege. The vital superiority and extra safety of the circular block can be proved in two minutes at our works. We would have two surface planers working side by side, one with a "circular" block and the other with a "square" block. Next, take two strips of wood, say 2ft. long by 1¼in. square. We would hold and feed one of these strips almost vertically down upon the circular block, whilst resting against the inner gap edge of the front table, "as we have frequently demonstrated," and gradually the strip or stick will be trimmed shorter.

We would now invite the other engineer—if only we knew his name—to do the same on the square block machine, if he dare, and either limbs would be convulsively chopped off, or he might be pulled badly over the table. Just the same with a man's fingers. If caught with a square block, the fingers are dragged down, probably assisted by the nuts holding the cutters acting as feed rollers to drag down the hands for successive cuts—see his illustration, Fig. 1. The circular block prevents this, and there is nothing to drag the fingers down.

The writer of your article admits or states that the "capacity for damage" depends "on the size of gap between the tables." We expect he refers to the gap between the cutter block and the front of the table, because the gap between the front and back tables would not affect matters much. Has he, therefore, not proved himself by his own admission to be wrong in his conclusion, for there must be gaps of less size between a circular block and the edge of front table than in the case of square cutter blocks. It therefore follows that the circular cutter block is the safer, and very much the safer.

We, too, have had many sad experiences in connection with accidents, but we have never either known or heard of such terrible injuries having occurred with circular blocks as with the old square blocks. How is it? Only one answer, we think, and that is because the circular block is not nearly so dangerous—hence it is worthy of the name "safety."

A. W. Glover, M.I. Mech. E.

Leeds, February 27th.

RAILWAY SIGNALLING.

Sir,—The continually recurring accidents on railways, which are due, not to failure of the road or of vehicles running on it, but to the failure of the system of signalling now in use, surely indicate that it is time these were closely inquired into.

As signals are intended to give information to the drivers of trains, it is surely reasonable to expect that they should be made not only where they can see them, but where they cannot help seeing them—and also hearing them, if their minds should be occupied with other things at the moment.

When the M.S. and L. line was being extended to London, and on all favourable occasions since, I have tried to get a hearing for my ideas on the subject. They are (1) That signals should be made on the engine; (2) that drivers should be able to repeat them to the signalman to prove that he has got it right; (3) that the driver of a train standing in a section is instantly and automatically warned if another train enters the section; (4) that the driver of the oncoming train is at the same time warned there is danger ahead; (5) that the signalman is also informed that there are two trains where only one should be; (6) that the signalman should be able, by Morse or other code, to give instructions what to do; (7) that the present fog signals should be abolished; (8) that workers on the line should have a signal with them which they could fix on the line, and which would warn them, the driver of any train approaching, and the signalman in charge of the section that there was danger.

There is nothing in this which cannot be carried into effect easily.

Southsea, February 24th. J. Jackson.

BOILER PLANT TESTING.

Sir,—In your issue of January 12th, 1923, there appears under the above caption a letter from Mr. David Brownlie. I observe, also, that Mr. Brownlie has written a similar letter to *Mechanical Engineering*, of New York.

While the object which Mr. Brownlie has in view is laudable and important, I fear that it would not be advisable to do away with the method of testing boilers that he calls "too academic and impractical," for such tests show what a boiler will do when it is clean and well fired. When such tests are made, the utmost should be done to put the boiler into the very best condition and fire it in the best manner—if the conductor of the test knows how. It is no fault of a good boiler if it gives poor results when it is dirty and badly fired, and it is well known that the very best boiler can give the poorest results from defects of method rather than from intrinsic defects. Perfection of condition and method are definite and exact, but anything less is indefinite and inexact. The results of academic tests give results to which the every-day results should approximate as closely as possible. Guarantees of boilers are made by builders with the expectation that everything will be done to have the boiler in the very best condition, and guarantees of grates, stokers and other means of evolving heat from fuel are made with the same expectation. The academic test must therefore remain.

It is, of course, of the utmost importance that the practical tests which Mr. Brownlie advocates should be made in order to see what is going on, and every boiler owner should wish to look out for his own interests sufficiently to have such tests made in order that he may know whether there is need of setting his house in order.

I have looked through Mr. Brownlie's book, and it is evident from the results that he tabulates that there is abundant cause for his plea.

Boston, Mass. F. W. Dean.

THE ENGINEERS' CHURCH.

Sir,—May I appeal to engineers and managers of manufacturing firms whose offices are in Westminster on behalf of Christ Church, Victoria-street, which, owing to its situation, has been well called the Church of the Engineers. The present edifice was built in 1843, and is on the site of a chapel where in 1649 Sir Robert Horley trod the stained glass of the windows underfoot, and called it "dancing a jig to Laud."

Milton was a parishioner and Dick Turpin lived in a court hard by, so that even before consulting engineers came on the scene, great and notorious men lived thereabouts. During the last twenty-five years the neighbourhood has changed from a residential to a business centre, and the Rev. R. T. P. Kirk, the present Vicar, is following the practice of churches similarly situated, by holding regular week-day services, at some of which addresses are given by prominent laymen.

The interior of the church has not been renovated for very many years, and it is especially in need of electric light to replace the present awful gas lamps, which disgrace a district where there are more electrical engineers to the square mile than anywhere else in the world. Also alas! the heating apparatus is a coal eater and a smoke maker, both of which evils big engineering firms in Victoria-street know well how to cure.

Subscriptions are asked for the renovating fund, but as they are difficult to obtain in these days, it is suggested that firms interested in electric lighting and heating might subscribe in kind—for example, cables, fittings, lamps, heating boiler, piping, &c. It is estimated that the electric lighting will cost £300. By making a first-class job, engineers will be able to show clients how a church should be lighted and heated.

As a member of the engineering profession, I make a very earnest plea for this historic church. I think it is up to the engineers of Westminster to make it worthy of the rich city in which they do business.

38, Claremont-square, London, N. 1, E. Kilburn Scott.
February 22nd.

LAUNCHES AND TRIAL TRIPS.

Medon, steel screw motor cargo vessel; built by Palmer's Shipbuilding and Iron Company, Limited, to the order of the Ocean Steamship Company, Limited; dimensions, 423ft. by 52ft. 3in. by 32ft.; 8000 tons deadweight. Engines, single-screw driven by eight-cylinder four-stroke cycle single-acting Diesel engine; launch, February 2nd.

Sarpedon, twin-screw steamer; built by Cammell Laird and Co., Limited, to the order of Alfred Holt and Co.; dimensions, 517ft. 6in. by 62ft. by 39ft.; 19,400 tons load displacement. Engines, twin screws, pressure 220 lb.; constructed by the builders; launch, February 2nd.

Colorado, geared turbine steamer; built by William Gray and Co., Limited, to the order of the Ellerman's Wilson Line, Limited; dimensions, 450ft. 9in. by 57ft. 5in. by 32ft. 10in.; 10,560 tons deadweight. Engines, single-screw double reduction geared turbines, pressure 225 lb.; constructed by the builders; trial trip, February 7th.

City of Canterbury, passenger and cargo steamer; built by Swan, Hunter and Wigham Richardson, Limited, to the order of the Ellerman Lines, Limited; dimensions, 449ft. by 56ft. 4in. by 34ft. 1in.; 10,000 tons deadweight. Engines, inverted direct-acting quadruple-expansion, constructed by the Wallsend Slipway and Engineering Company; trial trip, February 13th.

Mooltan, twin-screw passenger liner; built by Harland and Wolff, Limited, to the order of the Peninsular and Oriental Steam Navigation Company; dimensions, 625ft. by 73ft. by 44ft. Engines, twin-screw, pressure 215 lb.; constructed by the builders; launch, February 15th.

Faraday, twin-screw cable steamer; built by Palmer's Shipbuilding and Iron Company, Limited, to the order of Siemens Brothers and Co., Limited; dimensions, 415ft. by 48ft. 3in. by 29ft. 3in. Engines, twin-screw triple-expansion, 21in., 34in., and 57in. by 30in. stroke, pressure 160 lb.; constructed by the builders; launch, February 16th.

Khandalla, twin-screw passenger steamer; built by Swan, Hunter and Wigham Richardson, Limited, to the order of the British India Steam Navigation Company; dimensions, 440ft. by 55ft. 6in. beam. Engines, twin-screw four-crank triple-expansion; constructed by the builders; launch, February 16th.

Engineering Golfing Society.—The Engineering Golfing Society held its fourteenth annual general meeting on Wednesday, February 28th, at the Institution of Civil Engineers, by permission of the Council of the Institution, the retiring captain, Mr. K. A. Wolfe-Barry, presiding. The annual report and accounts for 1922, which were presented, showed a satisfactory increase in membership and a favourable financial position. The following were elected as office bearers for 1923:—President, Sir Alexander Kennedy; Vice-Presidents, Messrs. D. A. Stevenson, E. L. Mansergh, F. J. Walker, S. Price-Williams, G. Midgley Taylor and W. H. Shortt; Captain, Mr. S. R. Lowcock; Honorary Secretary, Mr. W. L. Mansergh; Honorary Treasurer, Mr. J. R. Sharman; Honorary Auditor, Mr. S. C. Lewis; Members of Committee: Messrs. H. P. Allison, A. J. Boyd, K. A. Wolfe-Barry, H. G. Hale, C. H. Hayward, E. C. MacKellar, W. A. Tait, E. W. Timmis and A. Valon.

Railway Matters.

THE Southern Railway Company announces that road communication between the Isle of Sheppey and the mainland of Kent was restored on March 1st. Traffic over the bridge is limited to vehicles weighing not more than 7 tons.

ANOTHER step towards the better relations between American railway companies and their men, referred to in this column on February 9th, has been taken by the Railway Labour Board having decided that no change is at present to be made in the wages of the trainmen.

THE *African World* states that it is proposed to convert the railway between Luxor and Assouan from narrow to the standard gauge of 4ft. 8½in. This change will allow trains to run through between Cairo and Assouan, and will obviate the delays of trans-shipment at Luxor.

ANSWERING a question on the 15th ult., Lord Winterton said that the commercial bodies in India which favoured the *status quo* in railway management were the Madras, Bombay, Bengal, Burma and Chittagong Chambers of Commerce and the Upper Indian Chamber of Commerce.

THE Great Northern annual report says that the directors, in this, their last report, desire to congratulate the shareholders on being able to hand to the new—London and North-Eastern—company a property which has been maintained in a condition which will compare favourably with any railway in the kingdom.

REDUCTIONS in the charges for the storage of goods were made on the 1st inst. by the English and Welsh railway companies. The reductions are mainly in the labour involved in housing, stowing and unhousing, and the charges therefore have been dropped by from 33⅓ to 60 per cent. An additional free day is also being given on traffic for shipment stored at the ports.

IT having been suggested that now that the railway reports again give the information omitted since 1913, the monthly statistics might be stopped, it is pointed out that these statistics are statutory and contain much information not given in the annual reports. Their publication is not only useful to the companies, but necessary to the work of the Railway Rates Tribunal.

THE speech made on the 20th ult. by the chairman of the Caledonian Railway throws some light on the circumstances that have led that company to refuse the amalgamation terms offered. One of the main objections was the choice of the year 1913 as the basis for negotiations. The argument of the Caledonian Company is that its property has greatly increased in value since then.

THE sixth annual report presented to the annual meeting, on the 14th inst., of the Institution of Railway Signal Engineers, shows that 76 new members of all classes were elected during the year 1922, and that the membership is now 434. In succession to Mr. R. J. Insell, now the President, Mr. W. J. Thorrowgood, was elected Vice-president for 1923. The Presidential address urged simplicity in signalling, the use of power and automatic signalling, the adoption of automatic train control installed at the distant signal, and the systematic training of the signal engineer.

THE number of passengers carried by London's Underground transport undertakings—tubes, and omnibuses, but exclusive of tramways—for the year 1922, amounted to 1,171,927,766, which represents an increase of 72,049,844 passengers over 1921. The number of car miles run amounted to 163,401,602, being an increase of 7,555,618 miles over 1921; 1480 passenger cars were run in daily service on the railways, and 2800 omnibuses on the streets. No less than £1,334,000 was expended during the year in the provision of new rolling stock, constructional improvements, and extensions of the railways.

THE annual report of the Caledonian Railway Company observes, as to that company's amalgamation with the London, Midland and Scottish Company, that "it has not been found possible for this company to submit an agreed scheme. Accordingly, the Amalgamation Tribunal has intimated that it proposes to proceed with the settlement of an amalgamation scheme, in accordance with the provisions of the Act. Pending this settlement, it has been arranged that this company shall co-opreate with the London, Midland and Scottish Company in joint working of the system without prejudice to the interests of the Caledonian shareholders.

THE question of an extension of the Great Northern, Piccadilly and Brompton Tube or the Great Northern and City north of Finsbury Park—mentioned in this column on December 29th—was the subject of a question in the House of Commons now that Parliament has reassembled. Colonel Ashley, Parliamentary Secretary to the Ministry of Transport, said that the Metropolitan Railway Company, which owns the Great Northern and City, was considering whether any such extension could advantageously be constructed. No powers for any extensions at present exist, and the preparation of any scheme for submission to Parliament, with a view to obtaining powers or removing any existing legal difficulties, would necessarily take a considerable time.

ACCORDING to the Board of Trade returns, the value of the railway material reported during January was as follows, the corresponding figures for January, 1922, and January, 1921, being added in brackets:—Locomotives, £253,344 (£863,981, £547,428); rails, £139,243 (£415,585, £454,887); carriages, £202,346 (£106,592, £106,443); wagons, £191,077 (£529,909, £494,270); tires and axles, £32,777 (£67,095, £156,615); wheels and axles, £70,238 (£153,366, £249,114); chairs and metal sleepers, £30,840 (£211,876, £202,903); miscellaneous permanent way, £111,091 (£173,162, £225,647); total permanent way, £407,634 (£1,046,063, £1,378,393). The weight of the locomotives exported was 1954 tons (5288 tons, 3655 tons); of the chairs and metal sleepers, 2704 tons (13,527 tons, 9456 tons); and of the rails, 16,583 tons (35,928 tons, 17,953 tons). Locomotives to the value of £70,957 and of £23,603 went to India and the Argentine respectively, and rails to the value of £60,226 went to India, to the value of £29,288 to Australia, and of £26,315 to New Zealand.

Notes and Memoranda.

AN overhead travelling crane recently installed in the river Rouge repair shop of the Detroit, Toledo and Ironton Railway at Detroit, Mich., can lift a locomotive weighing 100 tons and turn it end for end in one minute. The crab has two sets of falls spaced 7ft. apart, and is mounted on a turntable.

A REPORT of the American Society for Testing Materials concerns welded vessels subject to pressure at ordinary temperatures. Some forty vessels were tested to destruction. The shells of most of them were 6ft. long and 2ft. in diameter, and made of ¼in. mild steel plate. Both electric and oxy-acetylene welding were used. The hydrostatic and hammer test showed that the welded pressure vessel, according to the regular formula for working pressure, has a factor of safety of about six.

IN a paper read at a meeting of the Yorkshire County Colliery Under-Managers' Association at Wakefield, on Saturday last, Mr. S. J. Wrigglesworth mentioned that the popularity of the electric safety lamp could be gauged by the fact that from 1910 to 1921 the increase of the number in use was from 2055 to 268,538. The number was steadily increasing, and it could be confidently anticipated that the time was not far ahead when, with few exceptions, the electric lamp would be the only method of lighting in mines.

DEPOSITS of glass-making sand have recently been discovered by pure accident, according to the *Auckland Weekly News*, at Mount Somers, Canterbury, New Zealand. Prospecting had been in progress for about twelve months, with a view to finding coal seams within easy access of the Government railways. After a 7ft. drive had been made to a length of 400ft., it was proved beyond doubt that an immense body of silica was present. This was at first looked upon as an obstruction to the coal-seeking operations. An analysis made shows that the sand contains no less than 99 per cent. silica.

AT the recent annual meeting of the American Association for the Advancement of Science, held at Boston, the Association as a whole declared itself unqualifiedly in favour of the metric system of measurement. The resolution is as follows: "That the American Association for the Advancement of Science reaffirms its belief in the desirability of the adoption of the metric system of weights and measures for the United States, and recommends that the units of the system be used by scientific men in all their publications, either exclusively or else with the customary non-metric units in parenthesis."

AN unusual electric arc-welding job has recently been completed inside a show cave in California and is described in the current issue of the *Welding Engineer*. It consists of a basket-work tower 100ft. high built up of spiral strips of steel and enclosing a spiral stairway. All the 7200 joints in the structure were welded by the electric arc. Compared with the projected method of construction using structural steel, the welded work shows to great advantage. The estimated weight of a bolted and riveted structure was about 13 tons, whilst the welded tower was a trifle over 3 tons. The cost of the welded tower was about £600, whilst the lowest estimate of the riveted structure was nearly £2500.

THE metallurgical field is insistently demanding a refractory material which will stand up under more severe heat conditions, states the Bureau of Mines. There are many other demands on a refractory for specific utilisation, but it must be primarily a material with a high softening point. The refractory further must not vary widely in acidity or basicity from the slag with which it comes in contact. With these considerations, together with that of economy in view, it is apparent that there are only a very few materials available for the purpose. It is proposed to start work in America on the system ZrO_2—Al_2O_3—SiO_2 with the object in view of obtaining fundamental data in regard to refractories, abrasives and quartz glass. The purification of the ZrO_2 has already been completed. An induction furnace in which temperatures up to 3000 deg. Cent. can be attained is being installed for this and similar work at the Ceramic experiment station at Columbus, Ohio.

IN concluding a paper on rubbing down paint work, read before the Royal Society of Arts, Mr. C. A. Klein said that all the objections raised by the master painters to the ordinary wet process of rubbing down have been met by the now suggested damp process, because—it is applicable to new paint; there is no spilling of water and no accumulation of wet paint dust on the floors; any surface which can be rubbed down with ordinary paper can be equally rubbed down damp with waterproof paper, and finally, the limited amount of water used, although sufficient to lubricate the abrasive, prevents dust and does not entail long delay in drying; further, what is of equal importance, the process is free of danger to the worker. It has been suggested in the United States that the dry rubbing down process can be replaced by one in which mineral oil is applied to the surface before sandpapering. This process does not appear to have any advantage over the damp process in which the use of water is advocated.

IN the course of a lecture delivered before the Association of Drop Forgers, Mr. Leslie Aitchison pointed out that a shortage in the steel cut-off for making a forging means that superfluous steel will not be forced out between the dies in sufficient quantity, and, consequently, that there will be little or no flash. This might appear to be a benefit; actually, it is a very serious danger, because there is no cushion of steel between the dies. As a result the dies come together on their faces and mutually give each other a blow, which is frequently of sufficient intensity to break one of them. If too much steel is taken to make the forging, there is a gross waste of material. The excess of steel is forced out between the dies in a comparatively thin squirt. This fin of metal is in close contact with the upper and lower dies, and consequently becomes chilled fairly rapidly, and the excess of material lying in the pattern cannot easily be squeezed out. A further consequence is, that as the scrap becomes cold very readily it tends to split under the impact of the dies. The splits in the flash tend to spread inwards and may actually proceed into the stamping itself.

Miscellanea.

THE personal landing tax, which is levied in the Netherlands East Indies and must be paid before sailing, has been raised, according to the *Netherlands Indies Review*, from 25 fl. to 50 fl. Those who arrive at a Netherlands East Indies port without having paid this tax will have to pay 100 fl.

IT is reported that a Cardiff syndicate has acquired a large acreage of land at Aberthaw, about 12 miles from Cardiff, and that negotiations are very advanced for the erection of a further large cement works, involving an outlay of upwards of half a million pounds. The site is not far from that of the Aberthaw and Bristol Channel Cement Works.

IT is expected that the new Stella coke-oven and by-product plant at Pelton will shortly be put into operation. It is able to deal with 12,000 tons of coal per month, from which there will be produced from 7000 to 8000 tons of coke, 400 tons of crude tar, 120 tons of ammonium sulphate, and 20,000 gallons of crude benzol. There are fifty ovens at present.

THE Durban Town Council has authorised the borough electrical engineer to obtain full particulars which will enable him to place a scheme before it of hiring out electric stoves to consumers of electricity. There are now 11,000 customers connected to the mains and heating devices are very freely used, the price of energy after the consumption of a certain minimum being ½d. per kilowatt-hour.

THE city of Lyons is experimenting with accumulator electric omnibuses, independently of the Compagnie des Omnibus et Tramways de Lyons. If satisfactory results are obtained, a concession will be granted to the applicant, who is prepared to establish a service embracing the main roads of the city and suburbs. The city will undertake to supply the water, gas, and electricity needed for the scheme.

ACCORDING to *Il Sole*, of Milan, the Swiss firm of Sutter, which is terminating the construction of the Locarno-Centovalli-Valle Vigezzo-Domodossola railway, has definitely obtained the concession for navigation on Lake Maggiore. The company intends to run a ferry-boat service between Laveno and Intra, and to carry on the goods service with specially fast boats. All the company's vessels will be fitted with heavy oil Diesel motors.

THE Harbour Board of Baltimore, Maryland, is attacking the problem of the pollution of the harbour water with waste oil, by means of a specially built vessel equipped with pumps and a large settling tank. The surface of the harbour is skimmed with the pump suction, and the mixture of water and oil allowed to settle in the tank. It is said that the shipyards round the harbour discharge to waste as much as 20,000 barrels of oil annually.

ALTHOUGH the imports of tin plates into the Netherlands East Indies show a decrease of about 2000 tons on the first ten months of last year, Great Britain's figures show an increase of nearly 2000 tons. The total imports for 1922, January-October inclusive, are 9523 tons, of which Great Britain sent 9492—31 tons less than the total. In 1921, 11,662 tons were imported, Great Britain's share being 7346 tons, during this period. America's exports to the Netherlands East Indies have fallen from 4105 tons to nothing.

AN exhibition of wheat, corn-cleaning machines, &c., will be held by the Argentine Ministry of Agriculture at the Rural Exhibition, Buenos Aires, from May 5th to 13th next. Seed wheats, corn-cleaning machines, corn mills, kneading machines, and selected seed corn of all kinds will be shown, and manufacturers and growers are cordially invited to exhibit. Exhibits, both of machinery and seed corn, will be admitted into the Republic free of Customs duty, and no charge will be made for exhibition space. Exhibitors not having an agent in Argentina may consign their exhibits direct to the Ministry of Agriculture, Buenos Aires.

THE American Bureau of Mines has issued a report embodying the results of an investigation into the matter of permissible electric drills, "permissible" referring to use in gaseous or dust-laden mine atmospheres. The report has been compiled by H. B. Brunot and H. B. Freeman. Two makes of electric drills have successfully met the requirements of the Bureau. The formal approval of these drills means that if they were inadvertently operated while immediately surrounded by an explosive mixture of gas as the result of accidental interference with the ventilation, the atmosphere surrounding the drill would not be ignited even though an explosion took place within the equipment.

THE United States Navy, War and Commerce Departments are organising investigations upon substances which are poisonous or repellent to marine wood boring animals and also upon the ways in which these poisons are effective. The investigations, themselves, will be designed to determine the relative toxicity of creosotes, commonly used for timber preservation, upon the species of ship-worms and also upon the limnoria or gribble. There are also several other groups of substances which are highly toxic to most animals and with which it may prove to be possible to impregnate timber with sufficient permanency to persist for a long period of years. Some of these materials may be found to be even more potent in protecting timber and cheaper to use than creosote.

IN a new find of asbestos in the Barberton district of the Transvaal faces have been exposed in the mine showing an alternation of asbestos and serpentine as regular as ruled paper. As a concrete example may be taken a face having a vertical thickness of 7ft., packed with seams, having fifteen per linear foot and increasing to thirty per linear foot lower down, consisting roughly of 40 per cent. asbestos and 60 per cent. rock. The regularity of the seams and the extent to which they have been traced—about 3 miles along the strike—afford evidence, according to the *South African Mining and Engineering Journal*, of the fact that the Joubertadal occurrence is probably unique in the history of asbestos mining, and it will undoubtedly form a valuable addition to the mining resources of the district.

THE GENERAL ELECTRIC COMPANY'S EXPERIMENTAL LABORATORIES AT WEMBLEY

(For description see page 228)

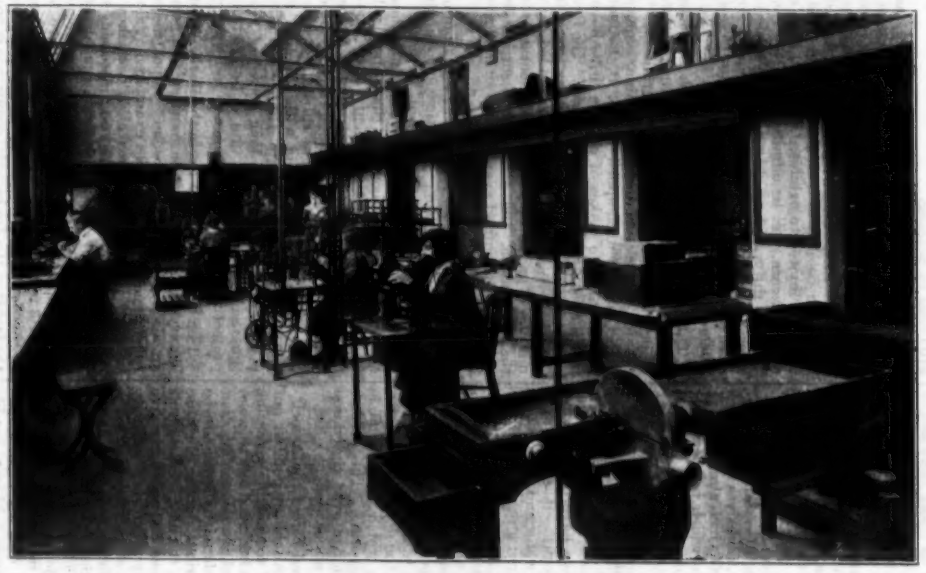


FIG. 7—THE EXPERIMENTAL LAMP FACTORY

FIG. 8—THE EXPERIMENTAL TUNGSTEN WIRE FACTORY

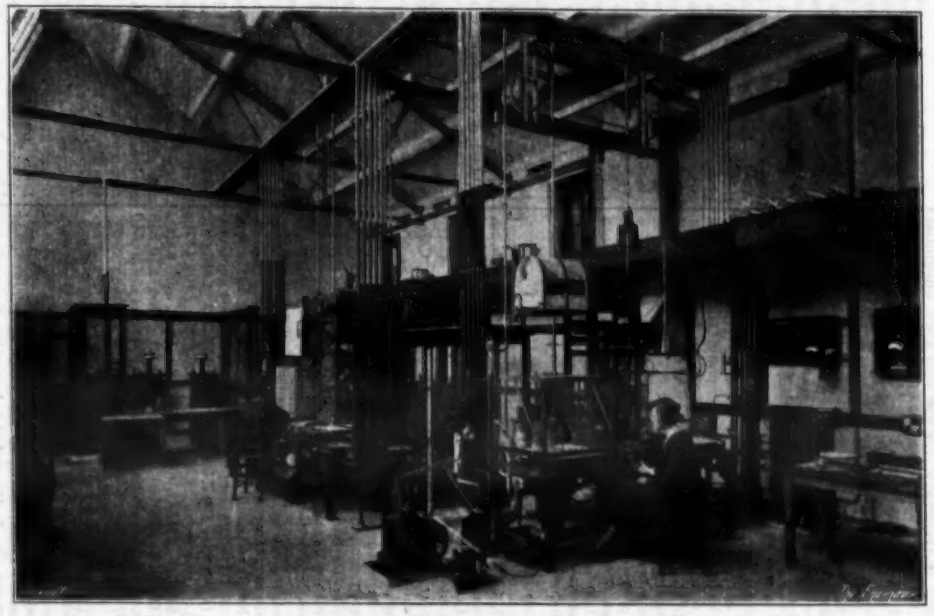


FIG. 9—THE EXPERIMENTAL VALVE FACTORY

FIG. 10—THE VACUUM PHYSICS LABORATORY

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SOUTH AMERICAN BRANCH OFFICE OF

The Engineer,

526, Bolsa de Comercio, Buenos Aires.

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THE ENGINEER can be had, by order, from any newsagent in town or country, at the various railway stations; or it can, if preferred, be supplied direct from this office.

Half-yearly (including index number) .. £1 12s. 6d.
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MARCH 2, 1923.

Civil Aviation and the Government.

WHEN the Government first undertook the subsidisation of the cross-Channel air services, it was estimated, or at least sincerely hoped, that at the end of three years the services would be financially self-supporting. On this assumption, the Air Ministry was authorised to expend £200,000 per annum for three years on the encouragement of civil aviation by means of subsidies and otherwise. Two years of the prescribed period have now elapsed, and no fewer than three different schemes of subsidisation have been tried, yet to all intents civil aviation appears to be as far off the self-supporting stage as ever it was. By March next year, when the present scheme ends, the Ministry, it is estimated, will have spent 85 per cent. of the total sum of £600,000 allotted to it on the payment of direct subsidies, the insurance of the aircraft, the provision of meteorological and other incidental services, and on a system under which the operating companies are enabled to acquire their machines on a very generous hire-purchase system. The first scheme tried was designed to promote competition between the British operating companies. During the year or so in which it was in force, the two companies earned a net revenue of £29,000 odd and incurred a total expenditure of £120,000, so that even the Government subsidy of £85,000—at the rate of £14 15s. per passenger carried—failed to enable them to make both ends meet. The second scheme again encouraged inter-British competition, but the passenger traffic did not come up to anticipation, and the Government had to provide, not only subsidies, but compensation as well, to a total amount of £66,000 odd, or at the rate of £11 5s. 10d. per passenger carried. The third scheme now in force has eliminated competition between the British companies by allotting a different route to each. It was initiated six months ago, and by March, 1924, when it should come to an end, if it is not meanwhile abandoned in favour of yet another scheme, it will result in an expenditure on subsidies estimated at £304,000. On the face of things, the subsidisation of civil aviation has been a complete financial failure. In spite of all the money that has been spent on it, the cross-Channel air traffic is still not sufficient to keep more than three single-engined aeroplanes in active employment. Yet the question agitating the official mind is not how the Government might secure in another way the results it seeks by the subsidisation of civil aviation, but in what manner the payment of subsidies should be continued during the next decade.

At the beginning of January a Committee was appointed by the Secretary of State for Air to advise on the best method of subsidising air transport in the future. In its report, just issued, that Committee has laid down a new principle with regard to the matter in that it recommends abolishing all those features in the earlier and the existing schemes which ensure to the operating companies a fixed income provided their services do not fall below a specified minimum. In practice, it has been found that as there was no incentive to go beyond the minimum, the minimum services required have been the maximum provided. How far the Committee's new scheme will succeed in abolishing this feature, we are somewhat doubtful. The scheme in essence involves the formation of an entirely new company, with a capital of £1,000,000, to which would be granted a monopoly of the civilian air services. To this company subsidies would be awarded—on what terms it is not stated—to an extent totalling £1,000,000, spread over ten years. The company's profits would be allocated to the payment of a dividend of 10 per cent. to the shareholders, the balance being distributed equally between the shareholders and the Government, until the latter had received a total sum of £1,000,000, when its interest in the company would cease. It is not our duty to criticise the financial aspects of this scheme, but we cannot avoid remarking that any commercial company relying on a Government subsidy for the payment of a dividend of 10 per cent. for an assured ten years is not taking much risk with its capital, and is deprived of a considerable incentive to development. From the technical point of view, the interest of the scheme centres round the revelation which it incidentally makes of the extent to which the future of civil aviation is in the hands of financiers and organisers, and the almost hopeless nature of the engineer's task of trying to assist matters by making technical improvements. It has been stated that of the cost of flying an aeroplane some 50 per cent. is accounted for by fuel charges. On this basis, the incentive to improve the economy of the aero-engine is very great, and as a consequence much attention is at present being paid to the development of the heavy oil fuel engine for aeronautical use, both privately and in the Government research establishments. Could such an engine be constructed, the fact that the fuel costs would amount certainly to not more than a fourth or so of those in an engine using petrol, would obviously result in a great reduction in the expense of flying an aeroplane. It would, in fact, reduce the actual flying cost by over one-third. This saving as applied to the operation of a regular commercial service is, however, quite illusory, for it is a saving on the actual flying costs, and not on the total expenditure. Exactly how the total operational costs are now divided, we cannot say, but in connection with the first subsidy scheme adopted by the Government, it is on record that the total cost of operating the aeroplanes amounted to 10s. per machine mile, of which sum 2s. represented actual flying charges and 8s. non-flying and overhead costs. Thus, the development and adoption of the heavy fuel oil engine would effect a saving of only about 9d. per machine mile, or about 7½ per cent. of the total cost. Going a step further and imagining that the machines could be flown without fuel of any description, the result would be a reduction in the total cost of only 10 per cent. Even "gliding" therefore does not present a way of escape from the financial difficulties.

With the engineer outweighed by the financier and organiser in a ratio of four to one, it seems useless to hope that civil aviation will ever become self-supporting as a result of purely technical developments, and if there is no prospect of its becoming so, any scheme of Government subsidisation, whatever its details may be, is a waste of time and money. It is evident that in order to make civil aviation a success, attention must be concentrated on the non-flying charges. Even in this direction, however, the position is not very promising, for under the first subsidy scheme—the only one for which complete operational figures are available—the complete elimination of all the non-flying and overhead charges would have left the net revenue only some £5000 in excess of the flying costs. It seems to us, therefore, that civil aviation presents very small prospect of ever becoming independent of substantial Government assistance, and such being the case the whole motive for providing such assistance calls for review. So far, the civil flying services have completely failed to provide anything but the very smallest outlet for the products of the aeroplane and aero-engine works. As a means of securing a reserve of machines for use by the Government in times of emergency, the value of civil aviation is small, and

will become smaller yet, for the developments of design are clearly leading to the establishment of an ever-widening gap between military and civil aeroplanes, not merely in the form of their internal arrangements, but in such fundamental matters as factors of safety. At the most, civil machines in wartime would be fit only for conversion to bombers and troop carriers, and would be quite useless for fighting or scouting. As a training ground for reserve pilots and mechanics, whose services might be utilised by the nation in times of stress, something, no doubt, may be said in favour of civil aviation. We submit, however, that £100,000 a year is a wholly exorbitant figure to pay as a retaining fee for the services of a dozen or so pilots and about a hundred mechanics. We are, in brief, in total disagreement with the view expressed by the Civil Air Transport Subsidies Committee that the development of self-supporting air transport companies provides the only means of assisting the Air Force in the matter of reserve machines and *personnel*, and of affording help to the aircraft constructing firms. If subsidies are required at all, we are more than ever convinced that they ought to be expended on the direct attainment of the national objects in view, and not upon an aspect of aeronautics which in some respects definitely cannot, and in others can only very problematically, attain these objects in a round-about manner.

Research.

The gift of one hundred thousand pounds made by Sir Alfred Yarrow to the Royal Society and the opening of the new research laboratories of the General Electric Company at Wembley raise once more the vexed question of the value of research in engineering. We say "vexed question" because there can be no manner of doubt that many manufacturing engineers are out of sympathy with scientific research, and are even disposed to regard industrial research with something more than indifference. The difficulties which have been experienced in establishing research organisations in the engineering trades and the small financial help which engineers are prepared to give to researches are sufficient indication of this fact, if anything more positive is required than the lack of active interest which is manifest on all sides. The reasons for this attitude are, we suggest, not far to seek. The first object of all manufacturing engineers is to make money, and they can do that more readily by continuing to produce standardised designs by standardised methods, with standardised materials than by introducing changes which involve capital outlay on new equipment and lead to many difficulties which are invariably associated with the production of novelties. From the financial standpoint, changes, other than those which are no more than the multiplication of the familiar, are a nuisance, and nothing would please the money-making side better than that progress in design and materials should cease. Fortunately for the world, competition is the constant enemy of conservatism, and in the continual effort to hold positions against rivals, all, or nearly all, manufacturers are obliged to employ new methods, machines and materials.

But there is happily still amongst us, though we fear in reducing numbers, a class of men who are engineers from the love of their calling. Men, that is, who are continually urged forward by the calls of higher efficiency, men who derive a real pleasure from the improvement of machines, and whose first thought is that greater aspect of engineering, the attainment of ideals, and not the money that can be made out of such developments as they introduce. Furthermore, we have men of pure science, men, that is, who give no thought to the industrial employment of their discoveries, but devote themselves wholly to the conquest of the secrets of Nature and leave to others the conversion of their work to practical uses. In our own sphere, Faraday stands out as the most obvious and most brilliant example of this class. Having so many divergent standpoints, it is small wonder that research remains a vexed question. We have, first, those who favour research just because it is research; then those who support it because it leads towards that ideal efficiency at which they aim; and, finally, those who are indifferent or opposed because they are satisfied with things as they are, and dislike the changes which are consequent upon new developments. It is the business of those who desire to organise researches to harmonise these differences, to show the opponents that unless scientific investigations are carried out trade will suffer, and to persuade the scientist to depart a little from his attitude of aloofness and consent to carry on his inquiries with half an eye to the industrial uses of his discoveries. It is in this direction that the great institutions can do, and are doing, their most valuable work. Pure industrial developments are best left to the industries themselves—either when acting in groups as under research associations, or as single units, as, for example, in the new research laboratories of the General Electric Company at Wembley. Such researches as those into corrosion, which the Institution of Civil Engineers has in hand; into steam nozzles, on which the Institution of Mechanical Engineers is engaged; or the failures of condenser tubes, which has been so thoroughly handled by the Institute of Metals, are essentially the very types of research upon which the institutions can best expend their energies; they are researches which combine at once science and practice, and we may justly anticipate that in the administration of its recent gift the Royal Society will most nearly satisfy the intentions of the donor when it makes allocations to the approved researches of the great institutions.

It is an unfortunate thing that the term Research is all too frequently applied to investigations which are not worthy of that name, for the misapplication of the word has done not a little to bring the thing itself into disrepute. Every university has now its research students—young men and women, that is, who under the directions of a professor engage in certain weighings, testings and tabulatings, which, however invaluable they may be as instruction in scientific methods, rarely or never rise to the height of real research work. We are confident that the professors themselves are quite well aware of the value of such investigations, that they are generally far more concerned with the educational importance of the work than with its intrinsic value, but the students are, with the ingenuousness of youth, only too ready to regard it in a higher light, and they are confirmed in that attitude by some professors who, with more sympathy than discretion, encourage them to print their "discoveries." Whilst it can never be said that the publication of new facts is valueless, it should be constantly kept in mind that a series of simple observations, uninspired by imagination and unaided by new methods or by the acute scientific examination of facts, is not in itself research. Let us reserve for that greater word such work as that of Faraday, Froude, Perkins, Joule, Pasteur, Roberts-Austen, and Darwin, and dub these lesser investigations "inquiries into," and we shall find that the mere mention of Research no longer raises that scorn which now it frequently, and not always unjustly, encounters.

Lathe Tools Research.

The Manchester Association of Engineers resumed its discussion on Mr. Dempster Smith's report on lathe tools on Friday, 23rd ult. The chairman, Mr. Chas. Day, in opening the discussion, asked the members for an expression of their opinions with regard to a tool which would, it was reported, last for twenty minutes at a certain speed and cut on a certain material. If, instead of being run to destruction, it was only in operation for a short period, say, five minutes, and after being taken off that job it was used again later, how long would it last? It was his opinion that a tool so used might be capable of running for a number of hours, as it was not until just before breakdown point that serious damage occurred.

Mr. Reed said that although a member of the committee, he was not altogether satisfied that the matter had been presented in such a form as to make it most useful to the practical man. There was a great deal of information, which if condensed and put in a more simple form, would be more easily understood by foremen and workmen. Until that had been accomplished, he did not feel that the full benefit of the committee's work would be derived from the report.

Mr. E. G. Herbert said he had read the paper with a great deal of interest, and had obtained a good deal of information from it, but had finished it not altogether without a slight sense of disappointment. It was stated that a high speed steel could be hardened and tempered to a temperature as high as 600 deg. Cent. and be as hard as it was before. Was it to be inferred that when the steel had been tempered it had gained some properties not possessed before? He had looked in vain for information showing how the tempering process had affected the tensile strength, resistance to breaking transversely, to breaking under impact, or failure under abrasion. It was true that some cutting tests had been made with steel so tempered, but Mr. Herbert had found it impossible to infer anything from the results, largely owing to the adoption of the misleading formula $V T^{\frac{1}{8}} = C$. That formula was said to give a fair measure of the performance of the cutting tool. The kind of measure it gave could be seen from the table on page 16, where a tool which cut for 11 seconds and failed had a cutting performance of 89. There was also another which lasted for half an hour and failed, its measure being 180, so that in the opinion of the Committee a tool which lasted 160 times as long was just twice as good. With regard to tests made to find a method of measuring the cutting capacity of the tool without cutting, Mr. Herbert was in accordance with the conclusions arrived at, but wished to express admiration of the Committee's optimism. The Committee appeared to have set out with the idea that it was possible to take a piece of cold steel, submit it to what might be termed a third degree examination, and so oblige it to disclose how it would behave when hot. The Committee had come to the conclusion that the only practical test of the cutting qualities of steel was the cutting itself—a conclusion from which some people had started a good many years previously. Mr. Herbert believed, however, that a good deal could be found out about the cutting qualities of steel when hot by testing the physical properties of specimens raised to temperatures at which they would be when cutting, but to try to find out anything otherwise was, in his opinion, a waste of time. Taylor, many years previously, had pointed out that the influence of an increase of traverse had a greater effect on the cutting speed than an increase of depth of cut. The Manchester Committee, in its original experiments, always tried to make deductions as to the relationship between area of cut and speed, and in one series of tests—on cast iron—it had made alternate alterations of cut and traverse. When it came to plot the speed against the area, it obtained not a curve but a staircase—a curve in which there were a number of steps corresponding to alterations of traverse, and gentle slopes corresponding to variations in depth of cut. Some years later, in connection with a paper read by the speaker before the Manchester Association of Engineers, he had examined the relationship in view of the theoretical evolution of heat involved in cutting, and arrived at a simple expression connecting the speed with the cut, which he called the cube law ($V a t = C$) and which closely agreed with Mr. Taylor's famous results. Mr. Herbert had made a diagram, which he showed to the meeting, from which he said it was evident that the cube law gave the same order of curve as the experimental results, though it did not agree exactly with them. When he had first put forward the cube law he had pointed out that it could not be expected to give very exact results as it took no account of the distortion of the chip—it had simply been got out on a calculation of the heat evolved. He suggested that the Committee should test the cube law, repeating the experiments, but instead of taking the theoretical undistorted thickness of the chip, the thickness of the chip as measured by the micrometer should be taken. The cube law did not sufficiently allow for distortion, and probably the distortion of the chip, as shown by its actual thickening, would come nearer to the experimental results and would give a simple expression for connecting cut, traverse and speed.

Mr. Carter said he would confine his remarks to the heat treatment and the methods of testing the heat treatment. In his opinion the most important feature of the report was that at last the futility of hardening at 1250 deg. Cent. had been realised. Even when the interim report was published in 1915, the Committee was still advocating 1250 deg. Cent. Hardening at that temperature was the cause of the scrapping of a large number of tools. With regard to the reheating temperature at 580 deg. Cent., that treatment only applied to 14 per cent. tungsten steel, not to 18 per cent. steel, with a suitable carbon, chromium and vanadium content, which would give better results when reheated to 640 deg. Cent. There were two things to be sought in every high speed steel—thermal efficiency and physical efficiency. It was mentioned in the report that the tools were ground by hand. He supported that method, which did not injure the tool, as did mechanical grinding. The diagram on page 7 was entirely wrong, as the problem had been approached from the wrong direction. The Committee had started with 1¼in. square steel hammered down, which altered the structure of steel, whereas it should have taken a bar and cut off segments. The results shown in Fig. 7 were also contradictory. He had been unable to find any reference to clearance angles—that was a serious omission, as the clearance angle on a turning tool was of as much consequence as the cutting angle so far as durability was concerned, and care should be taken that the clearance angle did not exceed 5 deg. He was of the opinion that a straight faced cutting tool was always better than a round nosed tool, other conditions being equal. It was stated on page 30 that an annealing temperature of 800 deg. Cent. appeared to be the best; as a practical man he thought that was much too low. In his opinion the best Brinell figure for good cutting efficiency and no breakage was 600.

Mr. Aabridge said he considered the most important part of the report to be on pages 21 and 22, where the Committee made the deduction that the performance of tools hardened at 1250 deg. Cent.

was poor compared with that of tools hardened at 1350 deg. Cent. The deduction that reheated tools gave a cutting performance slightly higher than that of tools which had not been reheated was somewhat misleading, and needed qualifying. From it people would believe that after hardening at 1350 deg. Cent. it was necessary to reheat to obtain greatest efficiency. What actually happened was that after hardening at 1350 deg. Cent. the Brinell figure was 650 or higher. The reheating was simply a tempering—as carbon steels were tempered to reduce hardness—and brought the Brinell figure down to 600, which, as Mr. Carter had said, was undoubtedly the best. He had carried out some experiments on the effect of the volume of the cutter. He endeavoured to get 601 at first hardening, and the method he adopted was to arrest the cooling of the tool at some definite point. A small disc, ¼in. thick, 3½in. diameter, and in weight 10 oz., was taken from the furnace at 1350 deg. Cent. and put into another furnace at 800 deg. Cent. When the disc reached that temperature it was cooled, with the result that the Brinell hardness was 601. When cooled from 850 deg. Cent., however, the Brinell hardness of that disc was 682. Another disc 1in. thick, weighing 2 lb., when arrested at 800 deg. Cent., gave only 578, but at 850 deg. Cent. gave 600. A disc 4in. thick, weighing 8 lb., had to be arrested at 900 deg. Cent. to give 600 Brinell hardness. When 600 was thus obtained at the first hardening no further tempering was required, and the tool was in its best physical condition as regarded strength and cutting efficiency.

Mr. Pemberton said he regarded Appendix II. as the most important part of the report to the shop man. If it were given to foremen, a good deal would be gained. So far as tempering was concerned, he thought that after hardening at 1350 deg. Cent., tempering at 650 deg. Cent. increased the life of the tool, especially when taking heavy cuts. Although scleroscope tests might prove useful in the laboratory, under ordinary conditions in the workshop they were not found very practicable.

Mr. Simpson, as a member of the Committee, stated that the results given in the report did not cover the whole of the tests carried out in the investigation, though they were representative of all the work done. With regard to the expression $V T^{\frac{1}{8}} = C$, there seemed to be a certain amount of disagreement as to the advisability of adopting this formula. Within the limits in which it was used, the Committee had ample evidence in the experiments that it was a reliable comparative value. In these tests the Committee had always endeavoured to approach as nearly as possible to ordinary workshop conditions. With regard to scleroscope tests, the Committee had had in mind the desirability of finding some other measure of the quality of the tool than that of actual cutting. In his opinion, no success had been achieved, nor did he think it possible to attain any satisfactory conclusion. He thought it was generally agreed that it was preferable to keep the clearance angle as small as possible. The speeds and feeds used in the investigation were chosen to facilitate the experiments and not as any guide to what should be used in the workshop. Several tests had been made with the idea of showing what the plan angle of tool would be the best, and generally speaking, the finer the shaving for any given area of cut the better the results as far as power consumed and the life of the tool were concerned.

Mr. Chas. Day, replying to the discussion, said that an abstract of the report was in preparation. Before it was distributed, however, it would be necessary to obtain the permission of the Department of Scientific and Industrial Research, which had supplied the money to carry out the investigation and had published the report. Mr. Herbert had spoken of the Committee's optimism in seeking to find a method of testing the quality of the tools for the cutting performance. The Committee had thought it its duty to endeavour to find such a test, as it realised the immense value it would be to practical men. With regard to Mr. Herbert's remarks on Table 3 that the tests did not show reasonable comparative results, the Committee had used that table to show that the results obtained were variable and to endeavour to eliminate the variations. Although Mr. Carter had condemned Fig. 7, he had proceeded to confirm it by his experience. Fig. 7 was intended by the Committee to show that the scleroscope was no use for ascertaining the hardness, and could only be used to compare the hardness of similar pieces of steel. With regard to a question by Mr. Radcliffe as to the possibility of using the speeds and feeds given in the report for estimating the cost of production, Mr. Day stated that the figures were quite reliable, but the difficulty was to get the people in the workshop to work according to those figures.

Mr. Dempster Smith, in replying to the discussion, said that with regard to the question raised by the Chairman as to the effect of intermittent cutting, an inquiry into that matter was necessary, as very often tools set up in a turret lathe, for example, were only in operation for a few minutes and then retired, allowing another tool to come into operation. In replying to Mr. Herbert's question as to the change in the structure of the steel due to tempering, he pointed out that it would form the subject of another investigation. It was possible that a tool which had not been tempered when subjected to cutting would be raised to a high temperature, and on being reground the cutting edge might be formed at that part of the tool which had a temperature in the neighbourhood of 450 deg. Cent., and if the permissible cutting speed followed the hardness indication the tool would then have a lower cutting efficiency. By heating the tool to 580 deg. Cent., the possibilities of that occurring were more remote. Mr. Herbert had drawn attention to the results of trials with annealed tools which practically failed to pick up the cut. The object of those trials was to show what was likely to occur when a tool had been frequently reground and the hardened portion entirely removed. The mistake made was in applying the empirical law, $V T^{\frac{1}{8}} = C$ to these tools. At the same time it was desirable to show the cutting performance of such tools with hardened tools against the scleroscope reading—as shown in Figs. 4 and 5. In ordinary trials such low durabilities, and even anything under 10 minutes, would be rejected, and the duration of the trials commonly obtained was shown in trials immediately preceding those referred to by Mr. Herbert in Table 3. The Committee was desirous of establishing some workshop test which would indicate the cutting properties of the steel before being issued from the tool room. It was desirable that such tests should be carried out when the tool was cold, and whilst Mr. Herbert was entitled to his opinion, it could not be overlooked that there was a possibility of some relation existing between a test carried out when cold and that when hot. Further inquiry might show that a certain form of test when cold indicated a cutting capability of the steel when hot. With regard to the law advocated by Mr. Herbert, the Committee did not deem it advisable to give a law which would give the appropriate cutting speed with change in depth of cut, traverse, section of tool, shape of tool, &c., but contented itself with plotting the cutting speed for a two hours' run with a 60 deg. tool having ¼in. nose radius and a 70 deg. cutting angle. Any change in those conditions was provided for by the factors given in the text. With regard to Mr. Carter's observations on the heat treatment of steel, Mr. Dempster Smith said that the Committee in 1915, when it presented the interim report, did not advocate 1250 deg. Cent. for the high temperature treatment. The Committee at that time simply showed the irregular results which it was then obtaining, and sought from the members an expression of opinion as to where it was wrong. With regard to the hardness tests—given in Fig. 7—Mr. Dempster Smith learned with surprise that if a steel was properly drawn out the structure was injured. Provided proper means were available, it should be possible to cool a 1¼in. square tool just as efficiently as a ⅜in. square section tool. As evidence of that the Brinell figure for the specimens—shown in Fig. 7—were in the neighbourhood of 650, and in each set of trials the Brinell hardness figure for all sections was the same. Having regard to that high figure and the uniform readings, it could be inferred that all sections had been efficiently hardened and the tool steel had not been injured in the drawing down.

Contracts Going Abroad.

A DEPUTATION organised by the British Empire Producers' Organisation, and introduced by its chairman, Mr. Ben H. Morgan, was received on Friday afternoon last by Sir William Joynson-Hicks, Secretary to the Department of Overseas Trade, in the unavoidable absence of the President of the Board of Trade.

Mr. Ben H. Morgan, in introducing the deputation, said it was one arranged by the British Empire Producers' Organisation, and was one of the most remarkable that had ever placed its views before a minister of the Imperial Government, because it represented a preponderating majority of the industries of the entire British Empire. That prodigious body of opinion, he said, was unanimously in favour of the proposal that it should be obligatory on every Government Department and every railway and public body authority in the United Kingdom, to purchase goods entirely of British Empire origin, and to employ only British labour on their contracts and work. Not only was the burden resulting from unemployment greater than we could continue to bear, but unemployment was causing a measure of degeneration and social unrest among the workers, which constituted a menace to the State and to all schemes of peaceful regeneration. But more than that, the attitude of the Imperial Government in respect to Dominion and Colonial trade caused very deep misgivings in the minds of the British people overseas.

Australia, for example, in 1921 gave this country a preference in her tariffs amounting to no less than £8,000,000, and the comparative tariffs preference that was accorded to Australian products here did not amount to £300,000. New Zealand not long ago placed an order in this country for rolling stock at prices 10 per cent. greater than foreign prices, and that in addition to the great advantage which we derived from her preferential tariff. Those were only instances. Other Dominions and Colonies were every day giving us similar treatment.

He contrasted with this preference the things that are happening in this country. Only a short time ago the War Office passed over tenders from Australia and New Zealand for canned meat for the Army, and gave a contract for nearly one million tins to the United States. When the Dominion tenderers asked for definite details of the reasons for that action they were refused information. That example was only on a level with what was happening in the purchases made by a great many of our municipalities, including the L.C.C., which not only in respect to machinery and tram lines purchased foreign material, but also in connection with its housing scheme designed primarily to benefit the working classes of the country. He was credibly informed that even the Ministry of Pensions used foreign pencils. On the one hand, we were paying out something in the region of 100 million pounds a year for unemployment, and on the other hand, through lack of a sound Empire economic policy, we were deliberately adding to the ranks of the unemployed. How could we expect the Dominions not only to give us preference in their tariffs—without which British trade would be in a very parlous condition to-day—but expect their Government Departments and railway, dock and harbour authorities to continue to give us preferences in their purchases as they undoubtedly did, when a great purchasing department like the War Office and the first local authority in the Empire like the L.C.C. purchased without scruple from foreign sources. If something were not done there would be a great revulsion of feeling in the Dominions and Colonies against increasing or even maintaining the preferences on the products of the Mother Country.

His organisation had it in the strongest terms from its affiliated bodies in the Dominions and Colonies which control industry there that they will press locally for a compulsory measure that will ensure preferential purchases of Empire products by their Government Departments and public bodies if the Imperial Government will set the example. We should, therefore, by our own action increase the measure of home trade and employment and also add to the latter by stimulating export trade.

The deputation, therefore, asked for legislation which would compel all public bodies, Government or local, to give contracts only to British Empire firms, employing British Empire labour and materials, except under the licence of a Committee to be set up for the purpose and to represent the spending departments of organised industry and labour. He suggested that in the meanwhile the Government could put the principle into practice without legislation in all Government contracts and contracts requiring Government assent or guarantee, and urged upon them to do so without delay.

Sir William Joynson-Hicks stated, in reply, that both the President of the Board of Trade and himself were in full sympathy with the object which the deputation had in view, and that the matter had for a considerable time received the careful attention of the Government, and particularly of the Cabinet Committee on Unemployment. A distinction must be drawn between contracts placed by Government Departments or by local authorities in respect of works for which they received financial assistance from the State, and contracts placed by local authorities or public utility undertakings not so assisted. In the former group of cases the Government could lay down such conditions as they thought proper; as to the other cases they could only make recommendations to the local authorities or companies concerned. The matter was undoubtedly one of great and immediate importance, and the representations made by the deputation would be given full weight.

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THE MIDGELEY ENGINE INDICATOR

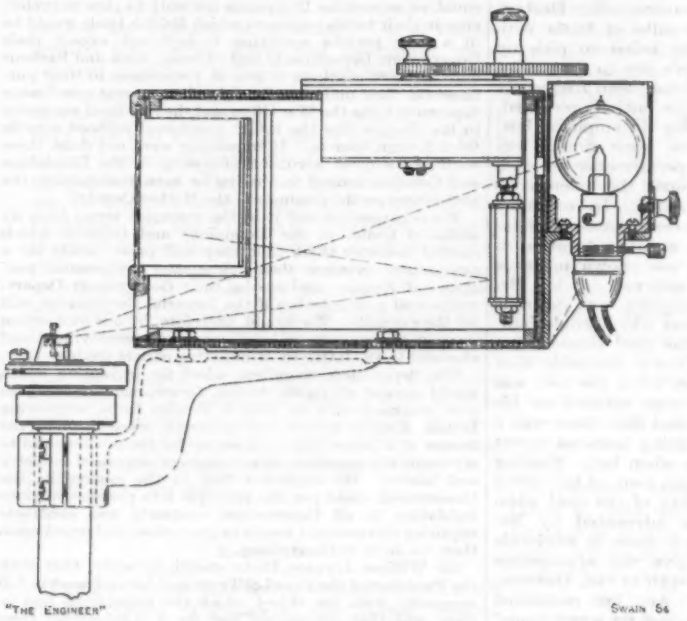


FIG. 1—GENERAL SECTION

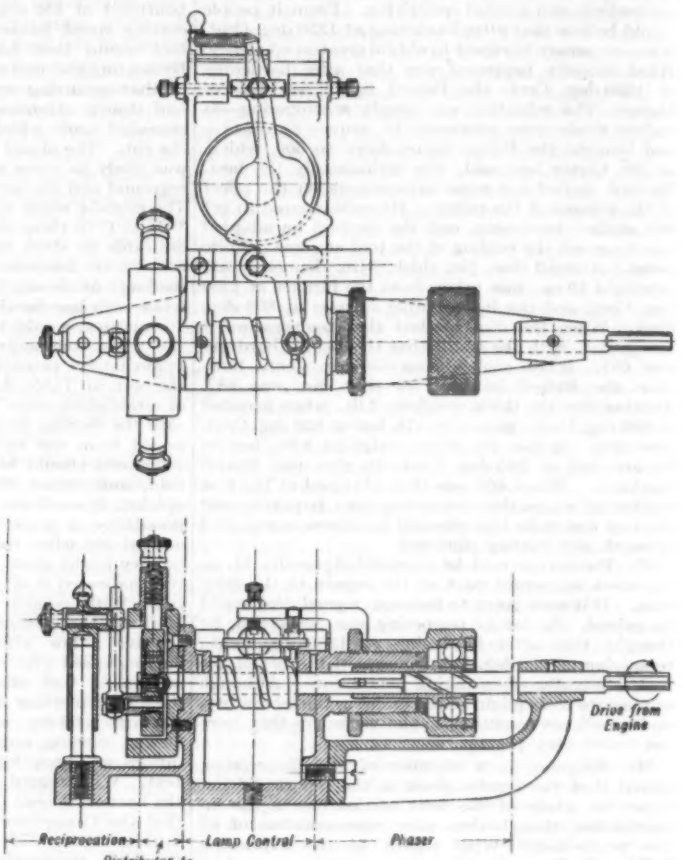


FIG. 2—SYNCHRONISER

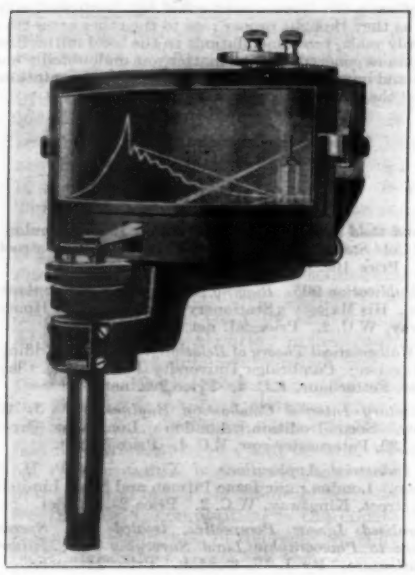


FIG. 3—GENERAL VIEW

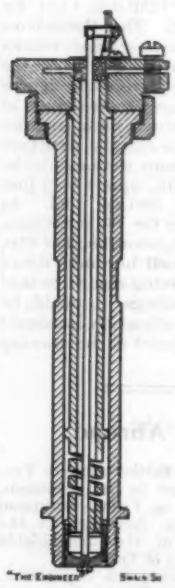
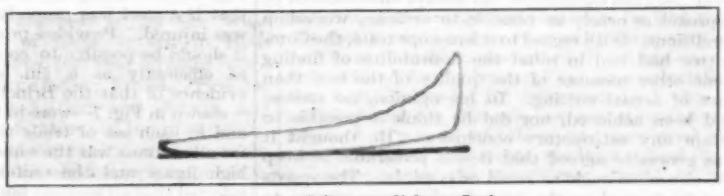
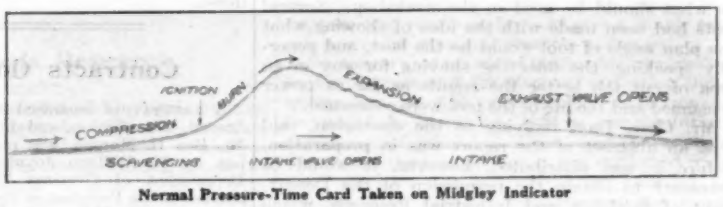


FIG. 4—SPRING AND CYLINDER



Conventional Pressure-Volume Card



Normal Pressure-Time Card Taken on Midgley Indicator

FIG. 5—TYPICAL CARDS

Engine Indicators.

AT the request of the local Committee of the Institution of Mechanical Engineers, the symposium of papers on "Indicators" was taken to Manchester on Thursday, the 22nd ult., and a general outline of the subject was given by Mr. Loughnan Pendred. Mr. A. Saxon, chairman of the Committee of the North-Western Branch, presided. Mr. Pendred brought with him a very complete collection of instruments, which were displayed in the smoking room of the Engineers' Club, and formed the subject of considerable conversation after the meeting.

In opening the discussion, Mr. H. W. Baker called attention to the Midgley indicator, which, he said, had so far escaped attention in the discussions which had taken place. This instrument, manufactured by the General Motors Corporation, of Dayton, Ohio, is an optical indicator of the piston variety. The diagram is traced by a beam of light from a metal filament lamp, the ray being reflected successively from two movable mirrors having their axes of motion at right angles to each other. The first of these mirrors is deflected proportionally to the pressure in the engine cylinder, the second either to the piston position or to the position of the crank. The first mirror being concave, the beam is brought to a focus, after the second deflection, on a ground glass screen which is curved to prevent distortion due to the large angular movement of the ray of light when taking pressure-crank-angle cards—Fig. 5. The body of the instrument consists of a steel tube—Fig. 4—which is screwed at one end into the cylinder wall so that, as far as possible the end is flush with the working surface. This end forms the indicator cylinder in which works a trunk piston $^{9}/_{16}$in. diameter. The piston is carried by an inner sleeve, clamped to the body tube at the upper end and cut to form a stiff spring just above the piston. The piston surface is practically flush with the walls of the engine cylinder. The motion of the piston is transmitted to the pressure mirror by a light central rod and bell-crank lever—Fig. 1. The second mirror group consists of a small octagonal prism silvered on each face and moving about its axis. When taking pressure-volume cards one face only is used, the prism being oscillated through a small angle by means of a miniature crank and connecting-rod driven at engine speed, the motion being transmitted by means of a fine steel wire or cable to an arm fixed to the mirror spindle, the wire being kept taut by means of a spring. The miniature crank may also be advanced or retarded relatively to that of the engine.

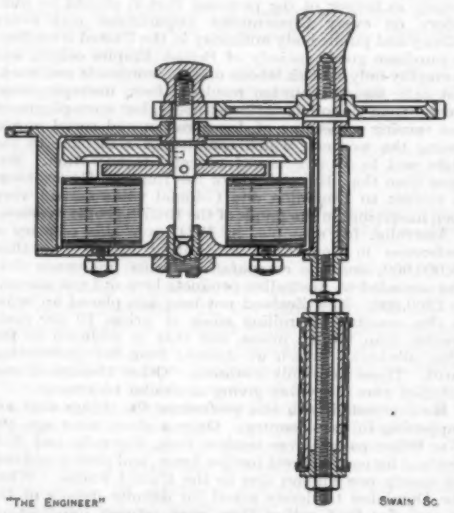


FIG. 6—SYNCHRONOUS MOTOR AND MIRROR

To obtain pressure-crank-angle cards the octagonal prism is given a rotary motion, being driven by a small electric motor synchronised with the engine by means of a distributor driven at engine speed. The speed and inertia of the motor are such that practically a pressure time basis is obtained, cyclic variations of engine speed being at any rate largely eliminated. The ray of light is reflected from one surface of the prism for half a cycle, and traverses the screen from left to right. The rotation of the prism then brings a second face into play, the ray again appearing at the left of the screen and making a second complete traverse during the remainder of the cycle—Fig. 5.

The pressure-time synchroniser is shown in Fig. 2. Here is seen on the left the reciprocator which actuates the octagonal mirror, next to it the distributor with three contacts, which controls the speed of the synchronous motor, and finally a worm which moves a swinging arm by the depression of which contact is made so that the lamp illumines the photographic paper for a single cycle only. The circle seen in the plan view is an electro-magnet which pulls the swinging arm down until it engages with the worm. The worm has two turns so that the stroke of the arm is completed in two revolutions or one cycle, of the engine. This complete apparatus, which is entirely separate from the indicator, is directly driven from the engine shaft. The synchronous motor is seen in Fig. 6. It is

geared at 8 to 1 to the shaft of the octagonal mirror, which is seen projecting downwards. The motor consists of six field coils and a simple armature of Siemens H form. The six coils are connected in opposite pairs, and each pair is connected with one of the contacts in the distributor.

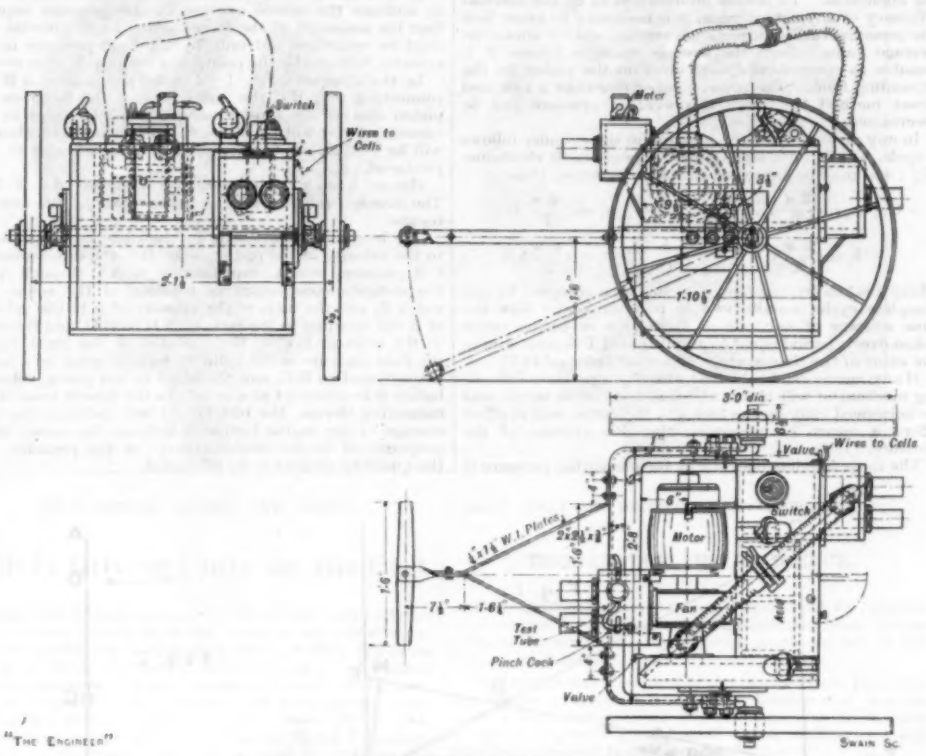
Mr. Cussons added a brief description of the Dalby Watson indicator, and showed a number of lantern slides illustrating the indicator and reproducing diagrams obtained with this instrument. He said that until comparatively recent times it had always been a difficulty to get sufficient light through the aperture to affect the photographic plate, but more rapid plates were now available, and that difficulty had been overcome, rendering high speed indicating much more satisfactory. With regard to the desirability of recording only one cycle of the engine, he himself thought it was really preferable to take several cycles, as it was only in that way that it was possible to know exactly what was happening. Mr. A. F. Burstall, in his father's absence, gave a detailed description of the indicator invented by the latter. Mr. Pendred had said that it had been found necessary to place a plain sheet of glass in front of the negative to prevent the latter being fogged by the oil vapour. That, however, only happened if the piston was over-oiled. When indicating petrol engines it was unnecessary to oil the piston, as sufficient oil was obtained from the cylinder itself. The only case in practice when it was necessary to oil the piston was with a gas engine, where the explosion was sharp and dry. It was always necessary to water-cool the cock and the cylinder of the indicator. No difficulty had been experienced with insufficient intensity of the light. The lamp was a "Pointolite," which has a ball of tungsten heated to incandescence, and gives about 100 candle-power. With an aperture .0025in. wide, a good fine line was obtained, a larger aperture caused too thick a line, whilst with a smaller aperture the light was not sufficient to mark the negative. Mr. Stromeyer suggested that with such a large and varied collection of indicators as had been assembled it might be possible, and would certainly prove useful, to make a comparison between them all, and thereby ascertain which indicator gave the best results. Although he had not seriously considered the standard to be adopted, he would suggest the one that gave the largest power. He would have appreciated some of the newer types of indicator some years previously, when measuring the loss of pressure in an engine due to the opening of the valve. The plan he adopted was to get cross diagrams, one ordinary diagram, and the other from the crank at right angles. That, however, was always a considerable trouble, and as it took some time to shift from one crank to the other there was a possibility of an alteration in the conditions of running, but he had obtained certain results in that way.

Disinfecting Railway Carriages.

IN India, the want has long been felt for some satisfactory method of disinfecting railway carriages. In that country there is not only the trouble from vermin, with which the carriages become infested, but also the risk of disease germs being left in them, necessitating disinfection and cleaning. Various treatments have been tried in the form of spraying disinfectants, burning poisonous preparations, &c., but not one has been sufficiently successful to say that it offers a means of perfect disinfection. One or other of them had to be practised, however, until something better was produced.

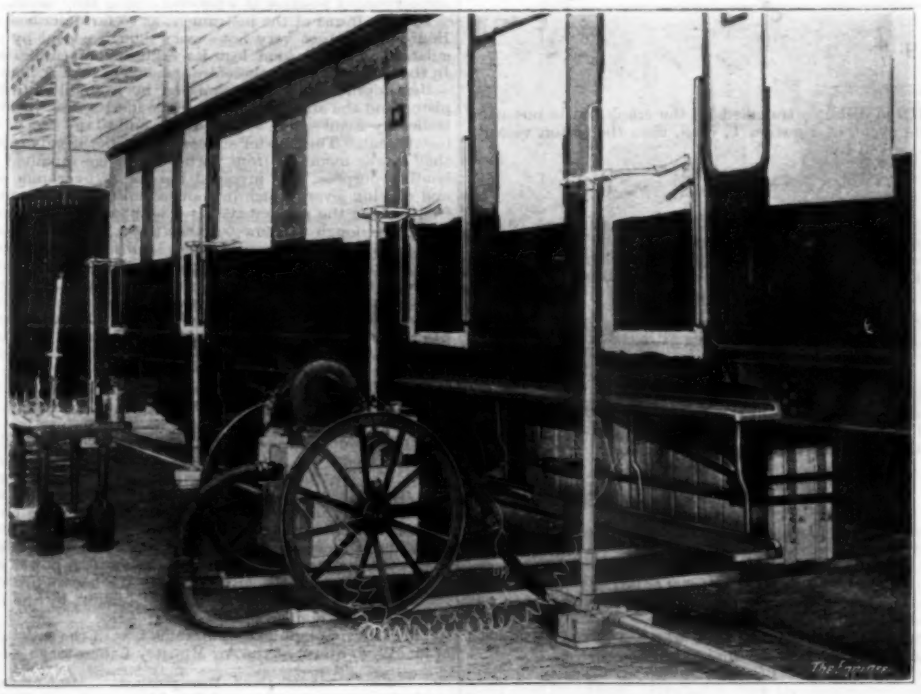
Recently the Great Indian Peninsula Railway Company installed a plant which is unique, and is said to be far in advance of anything that has so far been done in this direction. The system is one perfected by Colonel Glen-Liston, I.M.S., of the Bombay Bacteriological Laboratory, a scientist who has made a most careful investigation of not only plague bacilli, but almost every form of disease microbe. The particular apparatus which we illustrate and describe was made in the Matunga carriage shops of the G.I.P. Railway in Bombay, and is installed there for the treatment of carriages requiring disinfection. The method employed is very similar to that now fairly widely employed in disinfecting steamships. Briefly, it consists in generating a poisonous gas (hydrocyanic acid), which is forced and circulated through the infected coach until every portion has been impregnated and the vermin or germs destroyed.

The apparatus, which is illustrated in the accompanying engravings consists of a portable gas generator—mounted on wheels—in which there are two receptacles, one for sulphuric acid and the other for potassium cyanide. These two liquids are allowed to meet in a generating chamber, whence the resultant gas is "propelled" or forced into the compartments of the carriage through piping. The vehicle is prepared by closing up all windows, shutters, &c., and then applying temporary covers to them, through which the pipes conducting the gas are inserted. The joints are made gas-tight by having paper pasted over, and then the entire carriage is "sheeted" over with tarpaulins. When the carriage is prepared and ready, a small propelling fan, which is actuated by a 24-volt motor, receiving current from the train lighting cells of the carriage, is started and the two liquids mentioned above are allowed to mingle in the generating chamber. As the gas is generated, it is pumped through the carriage, the propelling fan delivering it on one side (right or left) through connections made with ordinary vacuum brake fittings, and exhausting it from the other through similar arrangements of piping. As soon as the gas generated, amounting to some 6 cubic feet, has been introduced into the carriage, the sluice valves connecting with the supply from the gas chamber are shut, and a by-pass opened whereby circulation of the gas-impregnated air of the carriage is maintained throughout the compartments for one hour. The carriage can then be left for the night and opened next morning, when all vermin, &c., will be found to have been destroyed. With proper care, there is no danger to the staff, as the gas rapidly disperses. For test, however, sparrows, which are very sensitive birds, are at times used. If one is put in and survives, then it is certain that no volume of gas exists which would be detrimental to human life.



APPARATUS FOR DISINFECTING RAILWAY CARRIAGES

This method of disinfecting carriages has now been used by the G.I.P. Railway for some time past, and all carriages reported to be infected by vermin, &c., are withdrawn from traffic and treated; the operation can be easily completed within twenty-four hours, and the vehicles returned to service clean and sterilised.



DISINFECTING AN INDIAN RAILWAY COACH

AUTOMATIC OPERATION OF POINTS, MERSEY RAILWAY.

IN our annual article, "Railways in 1922," mention was made of the automatic operation of points in the Liverpool Central, Low Level, Station of the Mersey Railway, a work which was, in a sense, a sequel to the automatic signalling described in our issue of July 7th last. As a result of his study of the conditions at this station, Mr. J. Shaw, M. Inst. C.E., the general manager and engineer, sought the assistance of the Westinghouse Brake and Saxby Signal Company, which had installed the automatic signalling, and the engineers of the latter company designed a system whereby a crossover road and a pair of trap points, together with the necessary signals, are actuated automatically. This device has enabled a yet more frequent service of trains to be run.

The station, which is the Liverpool terminus of the railway, has one island platform, with No. 1 platform road on the south side and No. 2 on the north. The platform roads are extended to form Nos. 1 and 2 sidings. A crossover is provided to enable trains to shunt from No. 2 platform road to either No. 1 or No. 2 sidings, and is so situated that a train arrives and stops at No. 2 platform just clear of the crossover road. A time arrangement is installed, which takes twenty to thirty seconds to operate, and ensures that the train remains within a certain section of the platform road for a definite time; this time being sufficient to ensure that the train shall have come to rest. At the expiration of this time, the crossover is reversed, and the signal is cleared for the train to run into No. 1 siding. When this train is in the siding, the crossover is again placed normal, and, provided that the other platform road is clear of trains, a pair of trap points is closed and the signal reading into this road is "cleared," so that the train may be reversed and brought to No. 1 platform, ready to load passengers for Birkenhead. For this train movement, no human operator is necessary in the signal boxes, but, should it be desired at any time to operate the points manually, it can be done by altering the position of a lever installed in the signal-box. By this action the automatic working is put out of service and manual operation must be employed for the movement of points and signals.

The new system of signalling was installed on February 4th, and on the same day Colonel Pringle carried out his inspection, and authority has been given to the railway company to bring it into use.

THE Railway Amalgamation Tribunal, on the 21st ult., accepted the allocation proposed by the Railway Companies' Association of the last of the 60 millions voted by the Railways Act.

New Means of Ascertaining Mean Pressure in a Heat Engine.*

By H. E. WIMPERIS, M.A., Superintendent, Air Ministry Laboratory.

In the operation of a high-speed engine the pressure in the working medium changes so rapidly that it is difficult to follow such changes accurately with any existing recording apparatus. To obtain information as to the thermal efficiency of any actual cycle, it is necessary to know how the pressure varies during each stroke, and to obtain its average value. Once the average value is known it is possible to compute the work done on the piston by the expanding fluid. The present paper describes a new and direct method by which this average pressure can be ascertained.

In any piston engine the pressure in the cylinder follows a cycle, which, on a steady load, repeats itself rhythmically; and may be expressed as a Fourier series, thus:

$$p = C + a_1 \sin \frac{2\pi}{T} t + a_2 \sin \frac{4\pi}{T} t + a_3 \sin \frac{6\pi}{T} t + \ldots$$
$$+ b_1 \cos \frac{2\pi}{T} t + b_2 \cos \frac{4\pi}{T} t + b_3 \cos \frac{6\pi}{T} t + \ldots$$

where p is the pressure and T is the time occupied by one complete cycle (usually two or four strokes). Now the time average of any one of these sine or cosine terms taken over a period equal to a multiple of T is zero. Hence the value of the time-average of p must be equal to C.

If any means can be devised whereby a pressure indicating mechanism will ignore the sine and cosine terms, and be influenced only by the factor C, the device will in effect afford a means of measuring the time-average of the pressure.

The most familiar instrument for measuring pressure is a Bourdon gauge; this contains a copper tube of oval cross section bent to a nearly circular form. Fluid pressure inside this tube changes its curvature, and this change of shape causes a pointer to move over a scale graduated in whatever pressure units may be convenient. If to an apparatus of this kind a heavy disc be added in such a way that angular motion of the pointer causes the disc to turn through a suitable angle, the response of the gauge to changes of fluid pressure can be made to be very slow. By increasing or decreasing the mass, and radius, of this inertia disc the response can be made slower or faster as may be desired.

It is known that the forced oscillations induced on an inertia mass controlled by a spring—the bent copper tube in this case—are very small when the period of the forcing oscillation is small compared with the period of the free oscillations of the instrument. If the amplitude of the forcing oscillations be A and their frequency be q, whilst the frequency of the free oscillations is f, the amplitude of the forced oscillations will be

$$A \cdot \frac{f^2}{f^2 - q^2}$$

Hence if the inertia mass be so designed as to cause the free period of the gauge to be twenty times the period of the forcing oscillation, the amplitude of the motion of the pointer will be but a quarter of 1 per cent. of the amplitude of the forcing oscillation. In such a case the instrument would read C, whilst the pointer would have a small oscillation of amplitude equal to

$$\frac{1}{400}\sqrt{a_1^2 + b_1^2} + \frac{1}{1600}\sqrt{a_2^2 + b_2^2} + \frac{1}{6400}\sqrt{a_3^2 + b_3^2} + \ldots$$

and for any probable values of the a and b coefficients this oscillation would be negligible. Hence in such a case the pointer would steadily indicate the value of C, which has already been shown to be the time-average of the pressure fluctuations in the cycle.

By this simple means the time-average of the pressure can be ascertained. If there were no other forces acting on the engine piston, this information would enable the time-integral of the pressure to be known. In practice the piston is constrained by the engine crank so that its velocity, and momentum, at the beginning and end of any cycle is zero. Hence the time integral of the fluid pressure is balanced by the time integral of the opposing forces. The work done by the engine per unit time is measured by the product of the stroke average of the pressure by the average velocity of the piston, and of course by the piston area. To measure, therefore, the work done per cycle it is necessary to know the average pressure not on a *time* basis but on a *stroke* basis. The instrument so far described may give indications of great interest, but it does not suffice to give the further information of the work done per cycle, and hence the thermal efficiency of the engine.

To modify the simple apparatus so far described so as to indicate the stroke average of the pressure requires that the moments of the forces acting on the inertia disc shall be controlled not only by the fluid pressure in the cylinder, but also by the position of the piston in its stroke.

In the diagram—Fig. 1—if A be the piston, A B the connecting rod, B C the crank, and F the force on the piston due to the fluid pressure, then the force in the connecting rod will be F. sec θ, and its moment about C will be F. C H. sec θ where C H is perpendicular to A B produced.

Hence moment about C = F. C H. sec θ = F. E C. The average value of this on a time basis is the average torque.

The length E C can easily be shown to be proportional to the velocity of the piston, since D—the intersection of C B produced and a perpendicular to A C through A—is the instantaneous centre of rotation of the connecting rod A B, and the ratio of the velocity of A to the velocity of B will be equal to the ratio of A D to B D, and therefore to the ratio of E C to B C. Hence, if the force due to the fluid pressure in the cylinder be multiplied by a factor proportional to E C, and therefore to the piston velocity, before it is conveyed as a couple to the inertia mass of the measuring device, the instrument will indicate the time average of the engine torque, which can be shown to be proportional to the stroke average of the pressure, *i.e.*, the quantity desired to be measured.

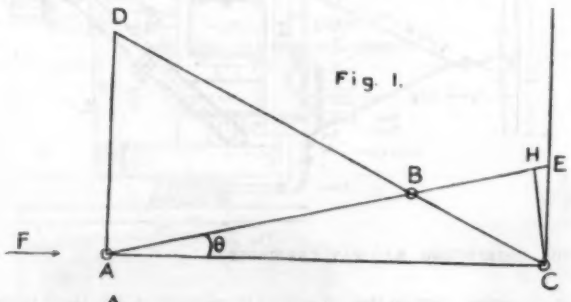


Fig. 1.

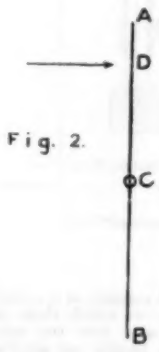


Fig. 2.

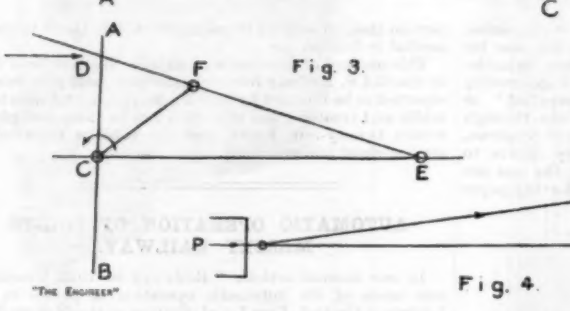


Fig. 3.

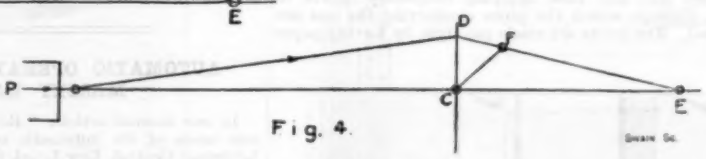


Fig. 4.

If the distance travelled by the crank pin in one complete cycle, of duration T, be S, then the piston velocity V is given by

$$V = \frac{S}{T} \cdot \frac{E\,C}{B\,C}$$

Assume for the moment that a mechanism can be provided in which the force due to the fluid pressure operates at the end of an arm having a length proportional to E C, then the instantaneous couple will be

$$k\,p\,.\,E\,C$$

where k is some constant. Replacing E C from the previous expression, this couple can also be written

$$\frac{k\,p\,r\,T\,V}{S}$$

where r is the length of the crank arm.

The time average of this couple, which regulates the instrument indication, will be

$$\frac{1}{T}\int_0^T \frac{k\,r\,T}{S}\,p\,V\,.\,dt$$
$$= \frac{k\,r}{S}\int_0^T p\,V\,.\,dt \quad \ldots\ldots (1)$$

But V can be written dx/dt where x is the piston displacement. Hence the integral becomes

$$\frac{k\,r}{S}\int_0^T p\,.\,\frac{dx}{dt}\,.\,dt$$

which in turn is

$$\frac{k\,r}{S}\int p\,.\,dx \quad \ldots\ldots (2)$$

taken over a complete cycle, *i.e.*, a quantity proportional to the stroke average of the pressure. If, therefore, the couple acting on the inertia disc can be controlled on these lines the pressure indicated by the apparatus will be the required stroke average of the pressure. It remains to show how to construct the apparatus to fulfil this purpose.

The Stroke-average Mechanism.—If the connecting rod-crank ratio of the engine be large the motion of the piston will be very nearly a simple harmonic motion, in which case the piston velocity will also approximate to a similar motion with a difference in phase of $\pi/2$.

Imagine a vertical lever A B—Fig. 2—pivoted at C, receiving a variable force acting at D in a direction perpendicular to the lever. Imagine further that the point D of application of this force oscillates between A and B in a simple harmonic motion. The resulting variable couple about the pivot C will approximate to the desired mechanism and for many purposes its accuracy would suffice.

Strictly speaking, the distance D C in the above diagram should be proportional at all times to the distance E C in the previous diagram, and for this it would suffice to provide in the measuring device a small model of the main engine mechanism. Thus, C F is a miniature crank, and E F a miniature connecting rod (of the correct length ratio). The crank C F would be caused to rotate about C at the same speed as the engine; and the connecting rod, produced as necessary, would cause the point D, where the normal force is applied, to oscillate between A and B in such a way that the length would always be proportional to the piston velocity.

An important question is whether A B can be maintained sufficiently vertical to represent in practice the ideal mechanism at which the construction aims. Obviously, if a null method of reading be employed, A B can be kept strictly vertical. For some purposes, however, a direct reading would be preferred, and in that case it would be necessary to ensure that the angular motion of A B should be limited to a few degrees on either side of the vertical. The error so introduced might not be appreciable provided that the rocking were confined to, say, 10 deg. on either side of the vertical, and it would be a natural step to provide that the exactly vertical position should correspond to the probable value of the space-average of the pressure cycle.

In practice the connecting rod E F—Fig. 3—would have part of its length slotted to contain a sliding pin representing the point D, the rod A B being similarly slotted for the same purpose. It would remain to ensure that the force applied at D should be always perpendicular to the mean position A B. If it were applied by a straight rod fastened at its other end to the pressure receiving device—piston or other apparatus—on the line E C produced, as shown in Fig. 4, a further possible source of error would be introduced, but this with a rod of suitable length could be reduced within any desired limits, or avoided altogether by making use of the null method of reading.

Experimental Models.—An experimental model was made to read the time average of the pressure, by attaching to the pointer mechanism of an ordinary Bourdon pressure gauge a suitable inertia disc. From what has already been said it will be clear that this was only a rough approximation to the ideal design. It had, however, the advantage of being very readily prepared and of affording some indication of the soundness of the principle upon which the design was based.

The next model also made use of a Bourdon pressure gauge, but had the point of application of the force oscillated in a simple harmonic motion in tune with the engine revolutions. The apparatus, rough as it was, indicated quite steadily and showed at once the increase in the stroke average of the pressure as the throttle was opened. In the stroke average apparatus the pressures on the return strokes are, of course, subtracted automatically from those on the outward strokes, an essential point of difference from the time average instrument in which all pressures are accounted positive at whatever timing they occur.

In both forms of the instrument as so far described the Bourdon tube got very hot—even though cooled by circulating oil—and soon lost its accuracy of calibration. In the working model, therefore—shown in Figs. 5, 6 and 7—the Bourdon tube was replaced by a small indicator piston and the angular motion of the inertia disc was controlled by a coil spring attached to it and to the case of the instrument. This model suffered from the disadvantage that it was made up from parts of a gauge intended for another purpose, and involved the use of overhung pins and rocking levers which introduced an undue amount of friction into the apparatus. It was, however, considered accurate enough to show whether the scheme was worth proceeding with. It was decided to test the instrument on a single cylinder Benz engine. It was first calibrated by being subjected to a steady oil pressure with the reciprocating pin at its maximum travel. The deflections were found to follow a linear law, and on multiplying the scale by $2/\pi$ the corresponding deflection due to any particular pressure when the torque arm followed a simple harmonic motion was obtained. The free period of oscillation of the inertia disc under the spring control provided was 2.2 seconds, corresponding to 27 vibrations per minute; this with an engine speed of 270 revolutions per minute and over would mean that the needle would oscillate through 1 per cent. or less of the oscillations of the pressure. The instrument was then attached to the engine and the latter motored round; the correct phase adjustment was obtained by changing the setting of the phase box until the instrument read zero, *i.e.*, successive expansions and compressions of the air in the engine cancelling out. The engine was then run under its own power and a brake load applied. Readings of the mean pressure indicator were taken, at various brake loads, by the null method of reading previously described.

The following figures were obtained, with the assistance of Mr. W. J. Stern, at the Air Ministry Laboratory:—

Net brake load. lb.	Revolutions per minute.	Mean pressure deduced from B.H.P. lb. per sq. in.	Mean pressure from indicator readings. lb. per sq. in.
30.5	1000	63	74; 78.5
39.0	1000	81	88.5; 86.5
46.5	1020	96	117; 111

It will be seen that the instrument, in spite of its rough construction, gave readings of the right order of magnitude. The average value deduced from these readings for the mechanical efficiency of the engine would be 86 per cent., which is but little higher than the figure obtained by other methods, although, of course, it has been arrived at without any allowance for the motion of the engine piston being other than a pure simple harmonic motion. In the case of the Benz engine the connecting rod crank

* Aeronautical Research Committee—Reports and Memoranda, No. 803.

WIMPERIS MEAN PRESSURE INDICATOR—FIRST WORKING MODEL

FIG. 5—EXTERNAL VIEW

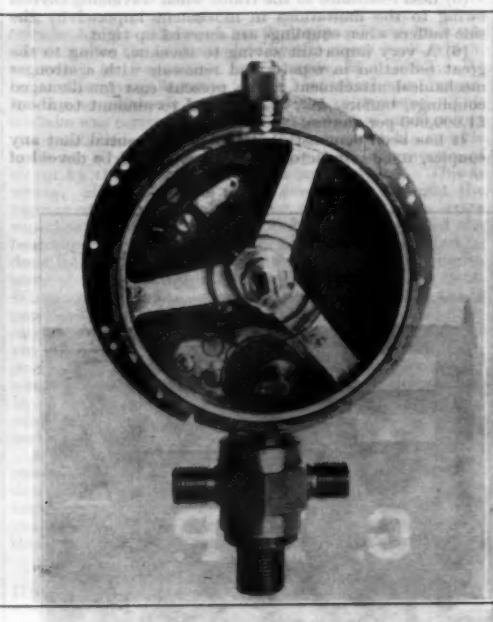


FIG. 6—INERTIA WHEEL AND SPRING

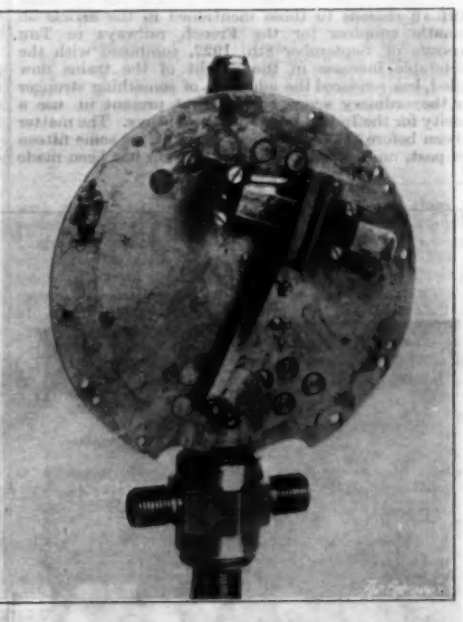


FIG. 7—PART OF RECIPROCATING MECHANISM

ratio was 3.5 : 1, and this might be expected to reduce the calculated mechanical efficiency by about 6 per cent., which would give a result agreeing well with other modes of measurement.

A new model will be made up in which the various forces and couples will be kept so far as possible in one plane in order to avoid racking strains and the consequent frictional constraints. For absolute measurements the null method of reading will probably be used, but for comparative measurements direct readings will, it seems likely, be found to be of sufficient accuracy, and they will, of course, be more speedily obtainable.

The main advantage of such a device is that it affords for the first time an instrument capable of reading the mean pressure in engines running at very high speed, and so of obtaining the value of the mechanical efficiency under these conditions. It enables, moreover, each cylinder in a multi-cylinder engine to be studied separately in order that the degree of equality of the fuel distribution may be disclosed. Measurements can also be made to determine the effect of detonation and pre-ignition on the mean pressure.

PERSONAL AND BUSINESS ANNOUNCEMENTS.

ELTON, LEVY AND CO., Limited, desire us to say that they have opened a branch office at 44/45, Exchange-buildings, New-street, Birmingham. It will be under the management of Mr. A. E. Adlam and Mr. C. P. Boas.

THE BRUSH ELECTRICAL ENGINEERING COMPANY, Limited, of Falcon Works, Loughborough, asks us to state that the address of its London office and registered office is now 88, Kingsway, W.C. 2. The telephone is Holborn 1220, and the telegraphic address "Magneto, West Cent."

THE SCOTTISH TUBE COMPANY, Limited, 34, Robertson-street, Glasgow, has opened up new branch offices and warehouses in Port Elizabeth and East London, South Africa. The Port Elizabeth office and warehouse is situated at 18, South-street, and that of East London at 22, Union-street.

CONTRACTS.

IN connection with the Hendon and Edgware extension of the tube railway from Golders Green, we understand that contracts have been placed with the Horseley Bridge and Engineering Company, Limited, for two steel bridges at Golders Green-crescent and Golders Green-road at a cost of £6687.

EX-BRITISH-WESTINGHOUSE ASSOCIATION ANNUAL DINNER.—We are asked to state that the annual dinner of the Ex-British-Westinghouse Association will take place on Friday, March 9th, at the Holborn Restaurant, London, and that there is still time to secure seats. Mr. A. R. Dyer, Chief Officer, London Fire Brigade, will preside, and those who have not yet obtained tickets can obtain them by applying to the hon. secretary, Mr. L. S. Richardson, 14, Sydney-road, Richmond, Surrey.

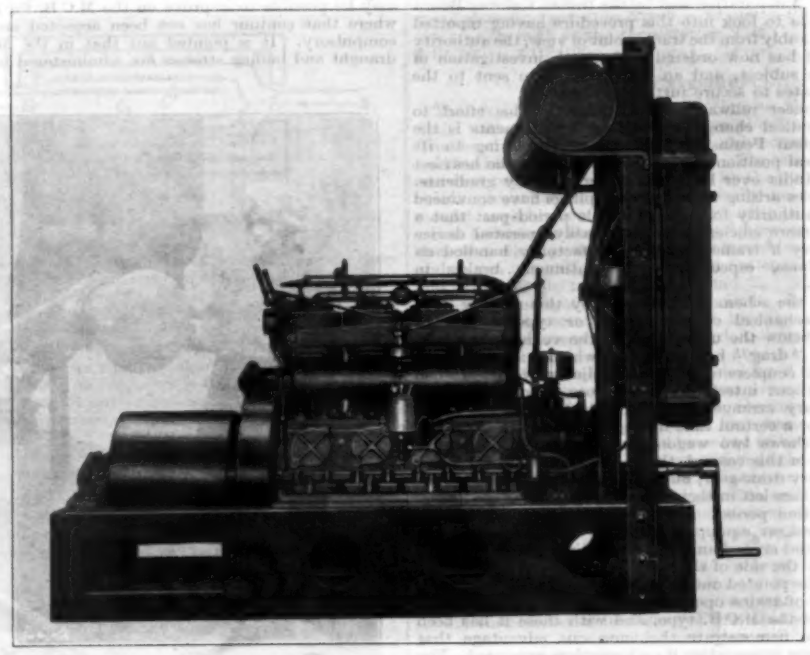
THE INSTITUTE OF COST AND WORKS ACCOUNTANTS.—The second annual costing conference, to be held under the auspices of the Institute of Cost and Works Accountants, will take place on March 9th, in the Connaught Rooms, Great Queen-street, W.C. The subject is "Standardisation in Costing." There will be a morning and afternoon session, and Sir Herbert Austin, K.B.E., will preside in the morning and Sir Max Muspratt in the afternoon. All interested in cost accountancy are invited, and tickets may be obtained from the secretary of the Institute at 38, Grosvenor-gardens, S.W. 1.

"OLD FINSBURIANS" AND "OLD CENTRALIANS" (MANCHESTER LOCAL SECTION).—A combined dinner of "Old Finsburians" and "Old Centralians" (Manchester Local Sections) was held on Friday, February 16th, at the Grand Hotel, Manchester, and was attended by about fifty old students. The chair was taken by Mr. A. G. Livesay (Local Chairman of the Old Finsburians), supported by Dr. E. Frankland Armstrong, F.C.G.I. (Local Chairman of the Old Centralians). Among those present were Mr. W. M. Mordey (President of the Old Finsburians Association), Mr. A. C. Cocksen (President of the "Old Centralians") and Professor W. E. Dalby, F.R.S., Dean of the City and Guilds (Eng.) College. This was the first joint function of the Associations, and any doubts that may have been entertained with regard to the desirability of joining forces of these two local sections for such meetings were entirely dispelled by the complete success which it attained.

Factory Driving Units for the East.

WHEN new industries have to be started and factories built in places remote from sea, river, or rail communication, the conditions of transport and operation are often such as preclude the use of heavy steam or oil engines for power purposes. A self-contained factory driving unit, with an engine of the standard 28 horse-power type, running at a speed of about 900 revolutions per minute, has just been completed by the Parsons Motor Company, Limited, of Southampton, with a view to meeting the requirements in such cases.

The illustration we reproduce shows one of a series of



SELF-CONTAINED POWER PLANT FOR THE FAR EAST

these units recently completed for shipment to the Far East. The engine, along with the outer bearing supporting the extended crank shaft and driving pulley, is mounted on a welded steel frame, which forms a common bedplate, and is stated by the makers to reduce vibration to an absolute minimum. The design is such that the frame need only be lightly fastened down in such a manner that the tension of the driving belt is resisted. A vertical frame carries the radiator and fan, and also supports the gravity feed fuel tank. Having in view the relatively high cost of petrol, compared with ordinary grades of paraffin, such as lamp oil, a special paraffin vaporiser is fitted to the engine. When starting, the engine is first run on petrol, or where only paraffin is available, a small blow lamp is used. High tension ignition is employed, and provision is made for a duplicate ignition system where conditions call for this. The capacity of the radiator and the cooling system is so proportioned that the engine may be run at full load over long periods, without requiring any make-up water. The plants and engine parts are made so as to be completely interchangeable, which facilitates repairs and replacements, and reduces the number of spare parts, where there are several engines in the same locality.

EDUCATIONAL INTELLIGENCE.

THE London County Council is prepared to consider applications for the following scholarships from British subjects, provided their parents or guardians live in the County of London :—

(1) *Intermediate Technical or Art Scholarships*, providing free tuition at recognised schools in London and, in some cases, a maintenance grant, for students from 16–18 years of age in engineering, technical optics, architecture and building, chemical trades, art, &c.

(2) *Senior Scholarships in Science and Technology or Art and Artistic Crafts*, providing free instruction at full-time day courses at institutions of University rank or at which advanced instruction in science, technology, art, &c., is given. They will enable students who are engaged in trades or occupations, and have attended evening classes for at least two years, to give up their day work and pursue a course of advanced instruction related to their employment. In some cases a maintenance grant will be provided, but it will not exceed £160 a year.

(3) *Free Places at the Imperial College of Science and Technology* for candidates at least eighteen years of age desirous of taking a post-graduate course in chemistry, engineering, &c.

(4) *An "Archibald Denny" Scholarship in Civil Engineering* of the value of £110 a year, providing training for two or three years at an approved polytechnic or technical school for a student between sixteen and eighteen years of age.

Detailed particulars may be obtained from the Education Officer (Technology Branch) at the County Hall, Westminster Bridge, S.E. 1., or may be seen in the "Scholarships Handbook," obtainable from Messrs. P. S. King and Son, Limited, 2 and 4, Great Smith-street, Westminster, S.W. 1., price 3d. (by post 4½d.).

Mechanical Couplers for the Indian Broad Gauge Railways.

SIMILAR reasons to those mentioned in the article on automatic couplers for the French railways in THE ENGINEER of September 8th, 1922, combined with the considerable increase in the weight of the trains now handled, has rendered the adoption of something stronger than the ordinary screw couplings at present in use a necessity for the Indian broad-gauge railways. The matter has been before the Government of India for some fifteen years past, and considerable investigation has been made as to how a reform in the coupling methods is to be brought about. It is common knowledge that the New South Wales Government Railways are carrying out a change from buffers and slack couplings of the British type to mechanical couplers, similar to those in use on the American railways. A deputation sent by the Indian Railway Board to Australia to look into this procedure having reported very favourably from the traffic point of view, the authority mentioned has now ordered a thorough investigation of the whole subject, and an officer has been sent to the United States to secure further information.

FIG. 1—WAGONS WITH MECHANICAL COUPLERS BELOW THE DRAW-GEAR

The pioneer railway administration in this effort to secure a radical change in coupling arrangements is the Great Indian Peninsula Railway, which, owing to its geographical position, has to handle perhaps the heaviest trains in India over lines abounding in heavy gradients. The troubles arising from screw couplings have convinced those in authority for a considerable period past that a stronger, more efficient and more easily operated device is necessary if traffic is to be satisfactorily handled on modern lines, especially with continuous brakes in operation.

Briefly, the scheme put forward by this railway is to attach mechanical couplers—form or type yet to be decided—below the underframe of the vehicles in a self-contained "drag" box or fitting, which will enable the mechanical couplers to be used on adjacent vehicles, when fitted, without interfering with those which have only the ordinary arrangements, and which will have to be coupled for a certain time during the transition period.

Fig. 1 shows two wagons provided with mechanical couplers—in this case of the M.C.B. type—placed below the ordinary draw-gear, but with the ordinary side buffers and draw-bars left in their original position for use during the transition period. The second engraving shows the end of a wagon equipped with one of these automatic couplers, and an Indian shunter standing in the operating position at the side of the line.

It may be pointed out that at the present time there is a number of trains operating in Bombay equipped with couplers of the M.C.B. type, and with these it has been possible to demonstrate the enormous advantage that would accrue in operating if such couplers were used. The loss of time in detaching or attaching vehicles with screw couplings in a busy shunting yard is so considerable that it is now looked upon as an absolute bar to further progress. Amongst the advantages which it is expected will be derived from the general introduction of mechanical couplers are :—

(1) A much stronger attachment, enabling heavier trains to be handled. It is the desire of the broad-gauge Indian railways to work up to a 3000-ton train. The present screw couplings fail by hundreds with trains of 1400–1500 tons.

(2) Securing a practically tight coupling on impact, a condition not attainable at present with the screw couplings with goods trains. The great majority of these are simply "slack" coupled, and left to run, owing to the unreliability of the Indian shunting staff. Such a condition is intolerable with continuous brakes in operation.

(3) A saving in tare weight of each vehicle, as only two couplings and buffing devices are required against six in the present type, namely, four buffers and two draw-bars with couplings.

(4) Increased speed of operation. From experiments made, the quickest time in which a screw coupling can be tightened up is about 30 sec., which means 25 min. on a fifty-wagon train, leaving out the time occupied by men traversing the length of the vehicles. In the case of mechanical couplers, this time is reduced to practically nil. The time occupied by the man passing along the vehicles to attach or detach brake pipes, &c., remains the same in either case.

(5) Less resistance to the trains when traversing curves, owing to the limitations in movement imposed by the side buffers when couplings are screwed up tight.

(6) A very important saving to revenue, owing to the great reduction in repairs and renewals with a stronger mechanical attachment. The present cost for damaged couplings, buffers, &c., is estimated to amount to about £1,000,000 per annum.

It has been demonstrated that it is essential that any coupler, to be satisfactory in service, should be devoid of links, shackles, pins, &c., liable to distortion; otherwise, in operating the heavy trains, anticipated complications are sure to ensue.

Two or three types of couplers are being experimented with, with different contours, as it is recognised that it may be possible to improve on the M.C.B. for a country where that contour has not been accepted and become compulsory. It is pointed out that in the M.C.B. the draught and buffing stresses are administered to one side of each coupler only, whereas it might be possible by modifying the contour to make the couplers of such form that these stresses are divided and taken on both sides of the couplers. This is provided for in the so-called Willison coupler now being put forward as a competitor with the M.C.B. It is not possible, however, to make any definite tests with such modified forms of coupler in the United States, owing to the universal acceptance of the M.C.B. as standard there, and the inability of the improved appliances to intercouple.

SHUNTER IN POSITION FOR OPERATING COUPLER

IN a lengthy paper which Dr. Russell recently communicated to the Physical Society he practically completes the discussion of the problem of two electrified spheres which was begun by the Marquis de Poisson in a paper to the French Academy in 1812. He adopts Poisson's method and shows how all the formulæ used in practice can be deduced by its means. He points out that for equal spherical electrodes at a fixed distance apart there is a definite size of radius which makes the disruptive potential difference a maximum.

Hydro-Electrical Situation in Spain.

THE exploitation of hydro-electric power in Spain, on which the country has spent over 1000 million pesetas, has not yet by any means come to an end, the difficulty of procuring good and cheap fuel and the lack of rail transport facilities being powerful inducements to investigate natural waterfalls in spots suitable for the creation of barrages. The consumption of current for lighting and industrial purposes is steadily increasing, and authorities on the subject estimate the power exploited at 600,000 horse-power and that of concessions granted at 1,500,000 horse-power, while the theoretically exploitable quantity is perhaps 7 to 8 million horse-power. There are many advocates of the use of electricity for railway traction, and as an example of such use may be mentioned the electrification of the Pajares ascent of 41 kiloms., which will join up the Asturian coal basin with the centre of the Peninsula. This work will most likely be completed in a year's time.

A very important installation which, if carried out, may contribute greatly to this transformation of the Spanish railways, is that known as the Saltos del Douro, which has been under investigation for several years, and which will be capable of supplying 300,000 horse-power. The commencement of the work has been hindered by the intervention of Portugal, which has claimed a share as owner of territory on the banks of the Douro. Meetings of delegates of the two countries were held with a view to arriving at an understanding, but no agreement was reached owing to the Portuguese demands, which the Spanish delegates considered excessive, and consequently nothing was done during the past year. The provinces of Salamanca and Zamora have protested against this paralysing, and demand that without neglecting the question of an agreement with Portugal, the falls on the rivers Esla and Tormés, which are situated in Spanish territory and represent a power of 200,000 horse-power, should be harnessed.

This concession, together with others less important of which little is heard, may meet with an obstacle in the decree of November 10th, 1922, which limits the length of a concession to seventy-five years in general and ninety-nine years in certain special cases, although this decree is a modification of that of June 14th, 1921, which limited a concession to a maximum period of sixty-five years and enjoined the use of Spanish machinery and materials. The concessions already under exploitation or construction at that date kept their character of perpetuity, but the new order, contrary to the law of 1879, put a sudden stop to the carrying out of all new projects on a large scale. Even in ninety-nine years it seems difficult to pay off the expenditure on the construction of the barrage and works, and at the same time remunerate the capital engaged.

Attempts will doubtless be made to obtain a modification of this decree, but one cannot be blind to the fact that it has powerful champions for its defence who will maintain with all their strength a situation which is in their favour.

With regard to the works in question, any delay in administrative formalities would lead to time being lost before they could be begun, even leaving out of account the difficulties foreseen in connection with the frontier zone between Spain and Portugal.

In spite of all obstacles, however, it seems reasonable to believe that the consumption of electricity in Spain will increase in a much larger proportion than that of mineral fuel.

UNTIL recently each platform at Piccadilly Circus, Leicester-square, Elephant and Castle, and Charing Cross Underground stations was provided with twelve 100-watt lamps. Larger lighting units have now been installed giving a general increase of 50 per cent. in the illumination. One effect has been to improve considerably the appearance of these important interchange stations, and, therefore, in addition to Oxford Circus and Tottenham Court-road stations, which will be similarly dealt with, the company is now considering the adoption of this scheme at terminal stations also. Careful stop-watch observations which have been made disclose the fact that the traffic at the stations with improved lighting moves quicker than it did before the new lighting system was installed.

Experiments on Superheated Steam.*

At the instigation of the Manchester Steam Users' Association the National Physical Laboratory commenced some experiments on superheated steam, which were published in the Memorandum of the Association for 1906. Nothing further has been done in this country since then, but Knoblauch's experiments have been continued in Munich, and Professor Thomas's experiments in America are also available. It may, therefore, be thought desirable to summarise and compare the results obtained.

The task has proved to be a very formidable one. The experiments by the National Physical Laboratory number 6, those by Thomas, 83; and those by Knoblauch, 133; making a total of 222. In addition, there are experiments by Holborn and Henning, but these fall out, because Brinkworth has shown that, in spite of all their precautions, their results for air are wrong, and probably also for steam. Dieterici, Smith-Griffiths, Henning—Joly, determined total heats, below atmospheric pressure, which might be used as a check, but are not of supreme practical importance. Grindley, Peake and Griessman determined specific heats above atmospheric pressure, but their results are so much out of harmony with other results that they cannot be accepted as correct. They effected their superheating by throttling, and measured the rise of temperature and drop of pressure. Their mistake, if it was one, seems to have been that they assumed the resulting velocity of the steam to be so low that its *vis viva* might be neglected, whereas, although the discharge pipe was wide and the average velocity low, the steam from the discharging nozzle may have impinged on the thermometer at a high velocity.

We, therefore, turn to the above three sets of experiments. Those by the N.P.L., being confined to a single pressure of 4.3 atmospheres, cannot be used for other pressures. They show a marked decrease of specific heat for rising temperatures. This was also the case with Knoblauch's first batch of experiments. Professor C. C. Thomas, who followed him, obtained strangely different results. This conflict of testimony was a most disturbing element and necessitated a very laborious analysis. Unfortunately, Thomas gives very little information with which to check his results, but Knoblauch is almost too profuse in this respect, though, as will be seen, some details are missing.

Knoblauch's 133 Experiments.

Arranging his 1907 experiments in the order of dates and examining his corrections for radiation, which were very conscientiously carried out after each experiment, three groups can be distinguished. Firstly, two experiments from August 9th to 11th, 1905, 14 experiments between September 14th and October 30th, and 11 experiments between November 16th and 30th. The radiation factors are fairly constant in each group, but differ amongst themselves. We may, therefore, assume that the calorimeter became tarnished while out of use between the several periods, the increase of radiation between October and November amounting to nearly 50 per cent. Possibly the calorimeter was occasionally cleaned, and if greased at the same time—oil was used as a heating fluid—this might have caused the alterations. There is, for instance, a very marked increase between November 21st and 24th. In each group there are a few discrepancies, and the question arose whether, instead of Knoblauch's individual corrections, group corrections should not be used. These would certainly have resulted in improved harmony. However, after several trials, it was decided merely to discard from the analysis any doubtful experiments.

The second group of experiments, extending from November 22nd, 1907, till July 26th, 1909, is similar to the first except that the group variations are reduced. There is a fairly progressive reduction of radiation from November, 1907, to December, 1908. Then there is a rest of about six weeks, and the radiation has now been reduced about 15 per cent. This reduction is maintained until July, 1909. There is only one serious departure from the average; its result has not been included in the analysis.

Probably, relying on the constancy of the corrections for radiations Knoblauch, in his last experiments, extending from February 7th to December 20th, 1921, made far too few radiation experiments, except as regards his last tests. He had, by then, evidently become aware that something had gone wrong, for the radiation factor, which starts at 0.41 in the first set of experiments, had declined to 0.25 in the second, which was undertaken a month later. Gradually its value was reduced to 0.10—less than one-half. Then there was a rise, and from October, 1921, a radiation test was made after each experiment, 11 in all. This was fortunate, for the radiation factors rose between November and December from 0.35 to 1.10. Under these circumstances it was deemed prudent to use only those experiments which were followed by correction tests for radiation. This decision ruled out all high-pressure tests except those of 22 atmospheres or 312 lb. The highest pressures used were 30 atmospheres, or 432 lb. Unfortunately, other experiments had also to be discarded. All Knoblauch's estimated specific heats have been checked. This could easily be done because of the very full details in his lists. Then, however, it was found that whereas the details and final results agreed in most cases, in others they did not agree. Here, evidently, there were misprints, and, seeing that the final results harmonise fairly well, it had to be assumed that the misprints were hidden away amongst the details. Yet it was the details, and not the final results, which had to be used in the present comparison. These doubtful experiments were also discarded. Nevertheless, nearly all these discarded results agree reasonably well with the others.

A further trouble arose due to variation in the recorded steam friction in the calorimeter. For instance, why should the friction in experiment No. 20 of the second series be 0.27 atmospheres, or nearly 4 lb. per square inch, and only 0.09 atmospheres, or 1.3 lb., in experiment No. 4, the amounts of steam being respectively 29.65 and 31.90? Even allowing for difference of temperature, the discrepancy is 1.5 lb. The adoption of an average coefficient of friction might have improved matters, but it might also have introduced a systematic error. Knoblauch's recorded values were, therefore, adopted. The most serious trouble, however, was that Knoblauch did not appear to have been quite clear in his mind as to the allowances to be made for these differences of pressure and the associated differences of temperature. When calculating the results of his first experiments he made allowance for the heat supplied by the steam itself, which, according to Regnault's experiments, is 0.305 T. He omitted to make allowance for the heat which was abstracted due to adiabatic expansion in the calorimeter. This mistake was corrected when the second set of experiments was published. Unfortunately he estimated his specific heats by dividing the heat supply per kilogramme of steam by the difference of steam temperatures. This is wrong. Having, by the above corrections, brought the ingoing steam and the outgoing steam, with its extra superheat, to the same level, he should have divided the heat supply by the difference of the superheats. Had he done this, all his specific heats would have been reduced, some of the low-pressure ones by as much as 4 per cent. When this correction is made, Knoblauch's results are in practical agreement with those of the N.P.L. This agreement encourages the belief that Knoblauch's experiments are reliable, and it is only to be regretted that his high-pressure experiments are far too few, more particularly when the apparently doubtful ones have been removed. In order to avoid making corrections the plan has been adopted of estimating the total heat both for the ingoing and outgoing steam and summarising the differences.

After several trials of formulæ which seemed to fit the case, each trial involving weeks of labour, it was finally decided not to force the result into a comprehensive formula containing both temperature and pressure factors, but to work out a formula for each pressure for which there were available a sufficient number of experiments.

$$H = A\,(T/100) - B\,(T/100)^2 + C\,T/100^3.$$

Here H is the heat required for superheating saturated steam to the superheat temperature T. The denominator, 100 deg. Cent., has been introduced in order to reduce the decimals of the coefficients:—B and C. Allowance has been made for difference of saturation temperatures and for expansion.

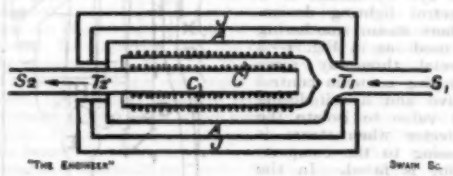
The results for the four low-pressure series are as follows:—

Pressure atmospheres 14.2 lb.	+ A.	− B.	+ C.
2	48.0	0.736	0.1315
4	49.0	0.554	0.1423
6	53.8	2.373	0.3623
8	54.4	2.520	0.0448

Adopting the same procedure for the 22 atmosphere determinations, for which, however, only 4 instead of 20 experiments are available, the result is

$$A = 80, -B = 0.315, C = 0.08.$$

The unsatisfactory nature of this last result might be due to slight observational errors, which would affect C



EXPERIMENTAL SUPERHEATER

and through it both B and A, but, as will be seen, there seems to be a systematic error either for the high-pressure or low-pressure results.

It is, of course, permissible to modify the above constants to a certain extent in order to attain harmony, but if average values are to be represented, the change of one constant necessitates a change of another constant. Thus an increase of A necessitates a decrease of B, *i.e.*, an increase of minus B and a decrease of C. Having adopted one set of values, say for A, an inspection of the B and C values would show whether they have now become irregular or whether they harmonise with the respective pressures. After a large number of trials, encouraging results being checked by calculations of the individual results, the following reasonably comprehensive specific heat formula was evolved:—

$$H = (42.8 + 15p)\,t - 3.6p^2t^2 + 0.45pt^3.$$

Here H is the heat in calories, which has to be added to saturated steam of the pressure P in order to give it a superheat temperature T. For convenience P/10 is expressed by p, and T/100 by t.

The following table gives a comparison of this formula with 12 groups of experiments. Against the ranges of superheat temperature S.T. of each group are noted the ratios R, of the estimated value of H, to the average of all the measured values.

No. of experiments.	Pressures.	S.T.	R.	S.T.	R.	S.T.	R.
	Atm.	Deg. C.		Deg. C.		Deg. C.	
24	2	9–200	0.983	237–368	0.993	368–472	1.012
24	4	47–128	0.988	136–342	1.015	353–446	1.026
18	6	37–80	0.973	119–212	1.012	214–434	1.036
18	8	30–139	1.010	144–209	1.008	240–370	0.987

As will be seen, the agreement is a fairly close one, the greatest discrepancies being − 2.7 and + 3.6 per cent. Unfortunately, however, this agreement does not extend to the high pressures of from 300 lb. to 450 lb., and between 120 lb. and 300 lb. practically no experiments are available. Nevertheless, following the same plan as above and retaining portions of the above formula, we obtain the following one for the high pressures:—

$$H = (42.8 + 15p)\,t - 3.6\,p^2t^2 + 1.05\,p^2t^3.$$

This formula is in agreement with the previous one at a pressure of about 4.2 atmospheres, and could be used both for the 2 and 4 atmosphere series, as will be seen from the following table, but it is hopelessly out of agreement

No. of experiments.	Pressures.	S.T.	R.	S.T.	R.	S.T.	R.
	Atm.	Deg. C.		Deg. C.		Deg. C.	
24	2	9–200	0.977	237–368	0.986	368–472	0.975
24	4	47–128	0.989	136–342	1.011	353–446	1.014
18	6	37–80	0.974	119–212	1.029	214–434	1.182
18	8	30–139	1.019	144–209	1.056	240–370	1.146
4	22	5	0.958	36–38	1.017	72	1.000
2	24	8	0.960	67	1.001	—	—
2	26	6	0.954	134	0.971	—	—
2	30	7	0.974	54	0.987	—	—

with the 6 and 8 atmosphere series. Should these two series be rejected and the second formula adopted? Preferably not, for the new formula is based on only 10 experiments with superheat ranges up to only 134 deg. Cent., whereas the other two series embrace 42 experiments with superheat ranges up to 472 deg. Cent. Probably the safest course is to adopt the first formula, but to limit its use amongst high pressures to cases of low superheat.

And yet the high-pressure experiments should not be rejected outright. They were carried out with an improved, though relatively small, calorimeter, and the fact that their results differ systematically from the earlier experiments suggests the probability that either one set or the other is afflicted by a systematic error, which cannot, however, be traced with such information as is at present available. This may perhaps be possible to Professor Knoblauch, for whom either of the above formulæ will provide a very simple means of comparing adjoining experiments and, perhaps, explaining discrepancies. It should be mentioned that one solitary determination was made with the new apparatus at a pressure of 2 atmospheres and low superheat. According to Knoblauch's table there is a discrepancy of + 4 per cent. in the result; according to his data the discrepancy is + 13.3 per cent.; but, comparing the superheat temperatures, the discrepancy is − 3.2 per cent.

This attempt to construct comprehensive formulæ shows up very clearly the uncertainties not only of the individual experiments but of the groups of experiments for the different pressures. In other words, it reveals the hopelessness of determining the specific heat of steam with a greater accuracy than is represented by plus or minus errors of 5 per cent., and it is to be hoped that at no distant date renewed attempts will be made to settle this very important question. It has grown doubly important since 1906 on account of attempts, and some of these have been fairly successful, to use steam of 300 lb. to 400 lb. pressures and temperatures which, in some instances, have exceeded 700 deg. Fah. The success of such engines depends to a very large extent on the ability of the steam with which they are supplied to carry its superheat to the desired stage.

Whichever formula may be adopted, we have for the mean specific heat $C = A/100 - Bt/100 + Ct^2/100$, and the specific heat at the temperature T is $C_T = A/100 - 2\,Bt/100 + 3\,Ct^2/100$.

Thomas's 83 Experiments.

The experiments by Professor Thomas will now be dealt with. They were undertaken about the time of Knoblauch's first experiments and unquestionably contradicted them, as will be seen later. The reason for this can most conveniently be illustrated by the diagramamtic sketch given herewith, of an electrically heated experimental superheater. Saturated, or partly superheated, steam passes into the superheater at S_1, traverses several sleeves—coils of pipe were used in the actual experiments—and passes out at S_2. The inlet and outlet temperatures and pressures are measured at T_1 and T_2. The heating is done by means of wire resistance coils C. In the actual experiments these were surrounded by oil, air or nitre solutions, and the steam was heated indirectly through these fluids. There seems to be no need for this complication. These coils were surrounded by a shell which was strong enough to resist the steam pressure. A was an air space. Why was this not an absolute vacuum? for then all convection losses would have been prevented and only radiation losses would have had to be dealt with. J is a steam jacket, and here we arrive at the difference between Knoblauch and Thomas. Knoblauch filled this jacket with steam of atmospheric pressure, and, therefore, its temperature was constantly maintained at 100 deg. Cent., a matter of no difficulty, though in those experiments in which the superheat temperature was high, the loss of heat from the oil bath would be great, for the oil bath had to be of a higher temperature even than the superheated steam. Nevertheless, frequent determination of the transfer of heat showed that this arrangement was satisfactory. It would have been still more satisfactory if, instead of merely repeating some experiments, Knoblauch had determined the heat required for superheating varying quantities of steam. This would have been a most conclusive check both on the heat losses, the pressure fluctuations, and on the radiations.

A better plan, but involving perhaps some important modifications, would have been to introduce a heating coil into the jacket J, and with the help of thermo-couples between the inner shell of this jacket and the outer shell of the calorimeter, establish equality of temperature. Then the heat losses would have been reduced to radiation of the inlet and outlet pipes, which, as these are beyond the thermometers T_1 and T_2, would hardly be noticeable. Thomas hoped to attain a more reliable result than Knoblauch by leading the completely superheated steam S_2 into the jacket J. By doing so he very materially reduced radiation losses, but not entirely, as he fondly imagined. He now suffered from systematic losses, and he lost all chance of checking his results. Although he covered J with non-conducting material, it would lose some heat, and, as the calorimeter would be hotter than S_2, and much hotter than J, considerable heat losses would occur. These losses would increase with increasing pressures and temperatures, they would be quite systematic and could not be checked. It cannot, therefore, be said that his results inspire confidence.

The absence of experimental details from his paper is

* From Mr. Stromeyer's Memorandum to the Manchester Steam Users' Association, 1922.

also an unsatisfactory feature. His results are reduced to unit quantities, and it is impossible to say whether one experiment carries more or less weight than another. Then also his readings seem to have been very rough. His thermometers were read to half degrees, against decimals of degrees by Knoblauch. At 400 lb. his thermometer readings are over ½ deg. below the tabulated temperatures for saturated steam, at 20 lb. they are too high. There is nothing to check the superheat temperatures. The heat supplies are given in round numbers: 5.6, 5.8, 6.0, which suggests an accuracy of only about 4 per cent. In spite of these many blemishes, it was deemed desirable to obtain mathematical expressions by means of formulæ which might be compared with those deduced from Knoblauch's results. Such formulæ would, at any rate, be of value as regards the saturation point of steam, which was not touched by Knoblauch. The heat expenditure in Thomas's experiments would, therefore, include W, the heat required to evaporate any moisture which might be contained by the steam

$$H = W + (At + Bt^2 + Ct^3).$$

Pressure.		W.	A.	B.	C.
Lb.	Atm.				
20	1.41	+0.039	56.60	−12.67	+5.06
35	2.46	+0.133	57.66	−12.12	+4.50
55	3.87	+0.095	58.76	−10.35	+2.94
75	5.27	+0.095	56.94	−5.45	+1.04
115	8.09	−0.135	55.97	−1.21	−1.12
165	11.60	+0.435	57.10	+1.81	−3.19
215	15.11	+0.800	54.91	+4.56	−3.78
300	21.10	+0.489	58.86	−0.86	−1.59
500	35.16	+0.153	62.59	−2.50	−2.69

This table should be compared with the previous ones. The values for W suggest that the steam was not perfectly dry. A is reasonably constant. Both B and C behave strangely, the one value rises while the other one falls with rising pressure. If we were to add corrections to represent the above-mentioned systematic errors, both for increasing pressures and temperatures, then A would increase in agreement with Knoblauch, C might become constant. The numerical value of B, excepting 165 lb. and 215 lb., would decrease at about the same rate as in Knoblauch's experiments.

There is, therefore, some hope that if Thomas's experiments were to be repeated they might harmonise with those of Knoblauch and confirm them, or, if not, they might reveal some source of error. There can be no doubt about the difficulty of accurately determining specific heats of gases, but from an engineering point of view the matter is of great importance.

It is to be hoped that any future experimenters on the specific heat of steam will carefully consider the several possible errors, and, rather than devise complications for estimating these errors, abolish them altogether. If such experiments should be undertaken, it would be desirable to follow Thomas, in part at least, and install one calorimeter for dealing with the steam as received, and determining its behaviour at saturation temperatures. After all it is at the saturation region that serious troubles are experienced in modern turbines. Then also the engine designer is far more interested in the reduction of superheat during expansion in the engine, than on its increase in a superheater, and it is to be hoped that in future experiments a third calorimeter will be added in which, by means of steam or water circulating in pipes or sleeves, or a power turbine, the superheated steam will be cooled. There should be no difference in the two results unless, and this is quite possible, rapidly superheated steam should consist of a mixture of various superheats.

Detecting Fire at Sea.

THE statistics of sea casualties compiled from the Board of Trade returns made during the twenty-three years immediately preceding the war show that fire losses are increasing, whereas there is a welcome decrease in marine accidents arising from other causes. Some actual figures are given by Sir S. Westcott Abell in a paper on "Sea

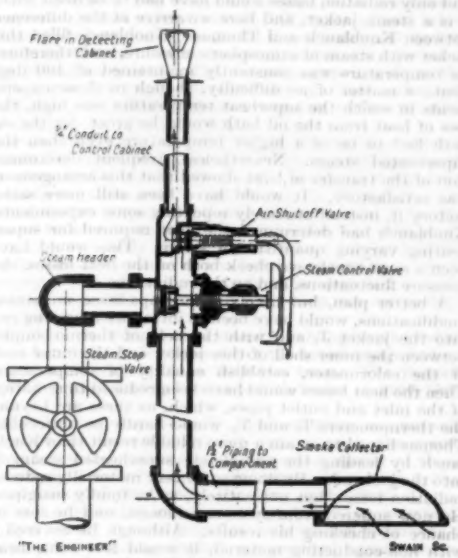


FIG. 1—ARRANGEMENT OF RICH SMOKE DETECTOR

Casualties and Loss of Life," which was read before the North-East Coast Institution of Engineers and Shipbuilders in November, 1921.

During the years from 1890 to 1913 the number of fire casualties, expressed as a percentage of the total number of steamships trading in foreign waters and registered in the United Kingdom, increased at a fairly constant rate from under 1 per cent. in 1890 to nearly 2½ per cent. in 1913. The same risks, taken out as a percentage of the total number of casualties, indicate a rise of from somewhere near 1.6 per cent. at the beginning to about 6 per cent. at the end of the period under review.

No figures are available, unfortunately, for the period since the war, but it is generally understood that the fire risk at sea remains at this high level, and, as far as information is available, the tendency seems to be in the direction of a still further increase. This fact is somewhat surprising when the developments made within recent years with fire-extinguishing and smothering devices are taken into account. The experience with fires in closed compartments—and it is estimated that nearly 65 per cent. of ship fires start below the superstructure, and of these nearly 75 per cent. originate in inaccessible cargo compartments—would seem to indicate the great importance of detecting a fire in the very early stages, and of dealing with it before it has gained headway. A well-established fire, it has been shown, is most difficult to control and confine whatever be the extinguishing system employed, and serious damage to the cargo and adjacent spaces in the ship is practically unavoidable.

A further factor of importance is that owing to the restricted air supply a ship fire is preceded by smoke, sometimes for days and even weeks before serious burning takes place, and the principle of smoke detection forms therefore a sure means of early discovery and generally of successful extinction.

THE RICH SMOKE DETECTOR.

The Rich system for detecting and extinguishing marine fires utilises the principle of smoke detection in a way which provides a continuous control of all compartments where the device is fitted. The drawing we reproduce in Fig. 1 illustrates the smoke detector combined with a steam smothering connection, which is the more usual arrangement, but the equipment can also be installed for detection purposes alone in cases where other means of extinguishing fire are already provided.

The principle on which the system works is that of drawing continuously a small stream of air from each of the compartments it is desired to control, and at one common point in the system—usually on the bridge—making the presence of any smoke particles clearly visible to the eye by means of a spectral lighting device. Where steam smothering is used—as in Fig. 1—a special three-way piece carrying a steam control valve and a self-closing air valve to isolate the detector when steam is passing to the compartment is fitted. In the larger installations these control valves are grouped in one or more control cabinets which are fixed near to the auxiliary steam supply in the engine-room or boiler-room. The necessary pipes comprise lines of ¾in. conduit from the bridge detecting cabinet to the control cabinet, and standard 1½in. piping from this point to each compartment, where the pipe terminates in a semi-circular smoke-collecting hood, which is attached to the plating in the upper part of the cargo space.

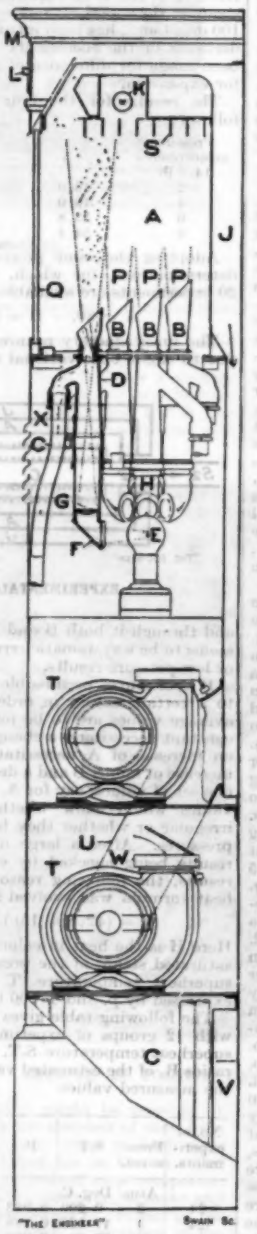
Particular interest attaches to the detecting cabinet, and the means employed to render visible the slightest trace of smoke present in the air stream drawn from any compartment. The views of the cabinet, which are reproduced in Figs. 2 and 3, serve to illustrate the method of working. The air current is drawn through the 1½in. steam smothering pipes and the ¾in. detecting pipes by the exhausting fans T, and passes through the pipe C to the bronze Y piece D entering the upper part of the cabinet A through the flare B. The lower part of the Y piece D is extended so as to carry a lens G and a mirror F, which receives light from the lamp E and directs a beam on to the upper part of the cabinet S where the light is absorbed by a blackened rough surface. The series of Y pieces is so disposed that each flare, numbered with the compartment it serves, projects an invisible beam of light P in the direction indicated by the dotted lines.

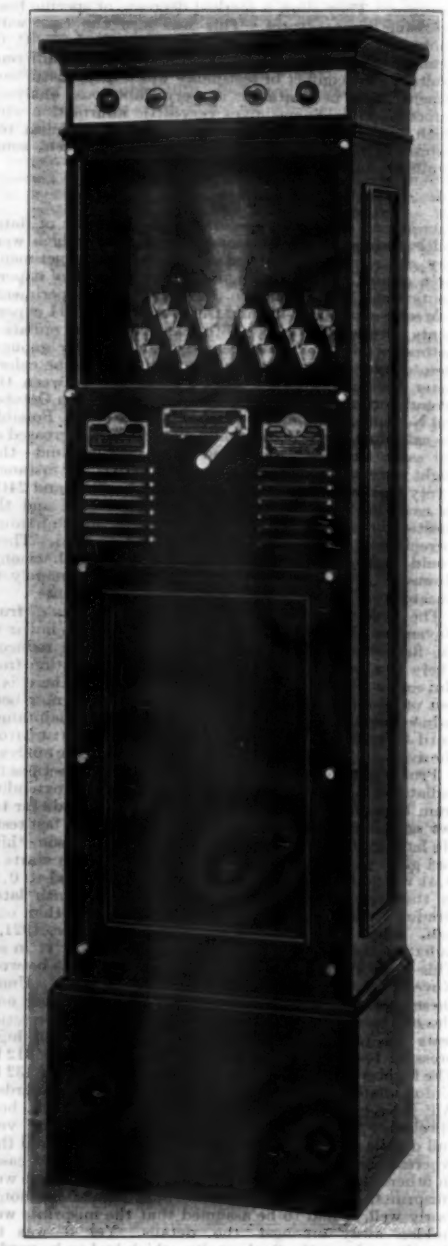
As soon as the fine particles of suspended matter which constitute smoke appear in the air stream, the light is immediately reflected and, viewed through the cover glass Q, appears as a sharp illuminated cone directly above the flare as shown in Fig. 2. In the ordinary way the air drawn from the compartment passes through the passage J down the connecting pipe U, and, leaving the fan chamber at W, enters the wheel house—where the detecting cabinet is usually placed—through the louvres X. This arrangement assists the officer on duty to detect any smoke by the sense of smell. In certain classes of cargo it is not possible to utilise this device owing to the obnoxious odours exhausted from the holds, and provision is therefore made to close the louvres X and expel the air to the outer atmosphere through openings at V.

For the purpose of illuminating the numbers and markings on the flares B an illuminating lamp K controlled by a switch L is provided. The alarms M at the top of the detector casing give instant warning when the exhausting fan motor stops or when one of the bulbs for the underlighting burns out. The motors and exhauster fans are specially constructed and are fitted with self-lubricated ball bearings. Each motor and fan will run for about six months continuously without any attention, and with the two units a period of over a year is covered.

The advantages claimed for the Rich system may be briefly summarised as follows:—The fire is indicated in the earliest stages of combustion before there is any appreciable rise in temperature, which affords an opportunity of extinguishing it at its very inception. Unlike other systems which depend on the development of heat, the detector continues to operate without repair after the fire has once been discovered. The collective control of the various compartments and spaces not only enables the exact position of the fire to be determined, but the effect of the preventive measures taken may be tested and adjacent compartments protected.

Some months ago we had the pleasure of examining the Rich smoke detector system installed in the White Star liner Majestic, and we understand that the Leviathan, of the United States lines, is now being fitted with a similar equipment. Other shipping companies which have adopted this system on their large new liners are the Holland-America Line and the Hamburg-American and North German Lloyd lines.





FIGS. 2 AND 3—THE RICH SMOKE DETECTOR CABINET

A SERIOUS collision occurred on Tuesday at Düren. A train from Aix-la-Capelle was turned on to the wrong line and crashed into a stationary train. The first two coaches were telescoped.

Provincial Letters.

THE MIDLANDS AND STAFFORDSHIRE.

(From our own Correspondent.)

Pig Iron Deficiency.

EACH week sees pig iron becoming scarcer and all the iron and steel industries of the Midlands are suffering more or less, directly or indirectly. The shortage is accentuated by the increasing difficulty in obtaining coke and the high price which is demanded for it. It was stated on the Birmingham Exchange to-day (Thursday) that no furnace coke could be got under 27s. 6d. per ton. The export demands for fuel are increasing day by day, and so the position is aggravated. There is little hope of relief so long as the conditions created in the Ruhr continue as at present. Smelters are not likely to court unremunerative business by re-lighting idle furnaces. In some districts furnaces are being put on slack blast, and if present conditions continue a similar course will have to be followed by some of the Midland furnace owners. Deliveries of Midland pig iron are difficult to obtain. Hematite is becoming very scarce indeed, and Northern firms are withdrawing quotations owing to inability to operate furnaces. There is practically a famine of all forge quality pig, and Northamptonshire grades are seldom quoted. When they are, the figures are intended to stave off inquirers. Prices of all Midland irons stiffen as the insufficiency of the supply becomes more apparent. Derbyshire smelters state they can get 90s. for forge iron at furnaces and that they have in some instances practically to ration their customers. For No. 3 foundry 92s. 6d. seems now an accepted basis, but 95s. is being asked. Staffordshire houses are quoting up to 100s. As is generally known, many furnace owners have closed their order books. The coke famine is the governing factor, with the Ruhr as a menacing background.

Ironworks Busy.

Demand for all Midland finished irons is very insistent, and most of the local ironworks have sufficient orders, with the plant at present in operation, to keep them going until the end of the quarter. Much more work could be booked, but manufactuers under present conditions are very chary of accepting forward commitments. Many firms in this district are being hit very hard by the failure of supplies from the Continent. Material for the re-rolling firms is arriving in rapidly diminishing quantities. Some cases of repudiation of contracts by Belgian and French exporters are now reported, while in other cases purchasers are required to hold themselves liable for any extra export duties that may be imposed. It has been the practice of some of these continental firms to accept orders by wire and in the confirming letter to stipulate conditions debarring the purchaser from claiming compensation for delay, non-delivery or cancellation. Several buyers in this district have let this go without protest, and are now suffering accordingly. Others have been careful to repudiate this modification of the original contract of sale. Makers of marked bars in Staffordshire are well occupied, continuing to do business on the basis of £13 10s. Quotations for merchant bars of Crown quality range from £11 10s. to £11 15s. at the works, and some makers are demanding up to £12 for urgent deliveries. Nut and bolt quality bars are dearer. Lancashire makers have again led the way with an advance of 5s. per ton, bringing their quotation up to £11 5s., which they claim to be getting. Staffordshire houses are not more than 5s. behind, however, not that in many cases. Business is at a standstill so far as Belgian bars are concerned. Quotations have been received this week round about £9 12s. 6d. in the Black Country, but buyers would have to trust to luck for delivery, and they prefer to place their orders at home. Iron strip has advanced a further 5s. per ton, bringing the quotation at date to £11 15s.

Galvanised Sheets Business.

Galvanised sheet firms, on account of the rise in sheet bar values and general difficulties in production, are stiffening their prices, and corrugated sheets of 24-gauge now range from £9 to £9 10s. The latter figure is readily obtained for urgent orders, but the high prices have checked the general demand. Buyers are exercising a considerable amount of caution, as some doubt seems to exist as to whether these high prices can be maintained. Makers meantime are called upon to pay £8 10s. to £8 12s. 6d. for their sheet bars, and that does not make for lower rates. The mills are quite well employed on orders placed at lower figures, and warehouse stocks have been replenished or are in process of being so.

Structural Steel Prices Advance.

Steel prices generally continue in the ascendant and in all branches of the trade keen activity prevails. Small steel bars have moved up to £10 10s., though occasionally one hears of business being done at a lower rate, round about £10. With Lancashire makers quoting up to £11 10s., minus carriage here, local houses have a command of the market. Staffordshire steel hoops command 5s. to 10s. above the official basis of £11 10s. Inquiries for structural material are on the increase, and Midland prices of joists, angles and plates have been advanced 5s., bringing the quotation to 10s. below the Northern level. Even higher prices are said to have been obtained locally. Makers of billets and sheet bars are taking advantage of the import situation to enforce increased prices. Billets are almost unobtainable and quotations are of little value, as actual prices vary from day to day. Certainly there were no sellers on the Birmingham market to-day (Thursday) at last week's price of £8 10s. For sheet bars £8 10s. to £8 12s. 6d. is asked. Demand for all kinds of heavy steel material is increasing. A number of new contracts have been given out by railway companies in this country and in India for bridges, general structural work, and carriage and wagon work. The quantities show a tendency to increase, but none of the contracts represents a particularly heavy tonnage, 600 tons being about the limit. Some of the shipbuilding firms, it is understood, for lack of normal occupation in their yards, have entered the market for structural work, thus increasing the already keen competition amongst contractors who complain greatly of price cutting in the fabricated work. Railway carriage and wagon building is also making increasing demands on the steel trade.

Wire Values.

Steel wire is dearer, £1 per ton having been added to the basis price of most descriptions for the home trade, and in a few cases for export. The standard for bright mild steel wire is now £20 per ton in 1 cwt. or ½ cwt. coils. Some movement of the kind was expected, and as a matter of fact has been anticipated by customers, who have covered themselves well ahead.

Rolling Stock Business and Foreign Competition.

At the sixty-ninth annual general meeting of the Birmingham Railway Carriage and Wagon Company, Limited, at Birmingham on February 23rd, the chairman, Mr. Alfred R. Windle, referred to the very acute foreign competition that they had to meet. It was a matter of great regret, he said, that much of the material required for railways situated in British Colonies and Dependencies should be so largely procured from abroad. Under the present circumstances it was impossible to meet this competition. The rate of exchange alone was an overwhelming handicap, to say nothing of taxation and transport charges. Speaking of the future prospects for the industry, he voiced the opinion that the uphill restoration of trade must necessarily be a slow process, and circumstances were largely controlled by the Ruhr occupation. It was quite possible they would derive benefit from this action of the French, for, owing to the failure of Belgian and German concerns to carry out their contracts in this country, a considerable increase of trade might accrue. It should be borne in mind that such benefits arising out of these adventitious circumstances could not be regarded as a permanent gain. The reduction of unemployment was a hopeful sign for the future, but the hopes of the industry lay in the improving trade overseas and in their ability to produce whatever type of rolling stock they were called upon to furnish.

Fuel Stringency and Railway Rates.

The coke shortage and railway transport charges were two of the topics discussed at a meeting on Monday of the Walsall and District Chamber of Commerce. Mr. W. J. Talbot, who raised the question of the effect upon British industries of the occupation of the Ruhr, pointed out that the Germans were importing large quantities of coke from the Newcastle-on-Tyne district and were paying spot cash for it. Our steel and iron industry was fairly well balanced, and if the Germans took the coke from the North-East Coast the result would be to unbalance the industry of this country and to bring about disaster. The price of steel and iron, in his opinion, would be doubled, and the cost of production would become so high that we should not be able to export our manufactured goods. He suggested that the Government ought to stop the exportation. Mr. L. C. Potts introduced the question of transport charges and urged that the time had arrived when they should strongly protest against the present excessive railway rates, which were extremely detrimental to trade. It was hinted at that manufacturers would be given the benefit of a 25 per cent. reduction, but they wanted something nearer 50 per cent. At the present time traffic could be sent by road at a cost of 25 per cent. below railway rates, and unless the railway companies wanted to encourage road transport they must make a bigger concession than that suggested.

Notts and Derby Miners and Trades Unionism.

There is a new movement on foot among Midland miners to counteract Socialistic principles in their trade union and to promote peace in industry and loyalty to the nation. Thousands of Derbyshire and Nottinghamshire miners have seceded from their respective unions and have founded an industrial protection union. The contributions of the members are to be used entirely for industrial trade unionism. It is felt by these men that it is impossible to free the present system from the domination of the Socialistic politician; hence this new move.

Unemployment Decreasing in the Midlands.

There is a further decrease in the number of unemployed persons registered at the various Labour Exchanges in the West Midlands area. The latest returns show that for the week ended February 19th there were 150,567 unemployed persons, as compared with 153,857 for the previous week, a decrease of 3290.

SHEFFIELD.

(From our own Correspondent.)

Heavy Steel Works Active.

THE heavy branches of the Sheffield steel trade, which produce billets for a large variety of commercial purposes, continue to enjoy great activity, and the volume of business is still expanding. Several additional open-hearth furnaces have been lighted up since my last letter, and the plant of this kind in the city is now employed to an extent approaching its full capacity, which, considering the great extensions that have been made since the outbreak of the war, shows what a remarkable change has taken place in trade conditions during the past few months. The present production of steel, in fact, is larger than it ever has been in the history of Sheffield. And yet there is no surplus of material. On the contrary, the demand for billets is in excess of the supply. This condition of things is leading some makers to refuse orders except at increased prices. It is generally hoped, however, that rates will not be allowed to soar to an unnatural height, as it is feared that this would do much to check the expansion of trade. No one wants to see a "boom," as such things lack permanency and are liable to end suddenly. A continuance of the steady growth of trade is much more to be desired.

Railway Work.

The departments which manufacture axles, tires, springs, buffers and other material for railway use continue to grow busier, every week seeing an increase of the amount of work on hand. Some large contracts for the home railway companies are under consideration. In this connection, the large programme of extensions announced by the London and North-Eastern Company is of much interest. This group of railways has schemes in hand involving an expenditure of approximately £2,000,000, and these will, no doubt, bring work to Sheffield, among other places. Besides the branch line from Colsterworth to Sproxton, near Grantham, to serve a new ironfield, the construction of which has previously been referred to, another branch is to be made from the main line near Retford to serve a new sinking in the South Yorkshire coalfield. Moreover, six short lines, costing about £650,000, are to be made in connection with the Hull and Barnsley line, and about £200,000 is to be spent on bridges and jetties on the North-East Coast. The locomotive building trade has not been very good during the past year. The Yorkshire Engine Company reports that the year has been a trying one, during which orders were difficult to obtain, and prices very low. The London and North-Eastern Railway Company is busy at the locomotive works of the Great Northern at Doncaster, where it is constructing ten express passenger engines of the "Pacific" class.

Other Steel Branches.

There is a gradual improvement in the condition of the rolling mills and forges, which have been quiet for a long time. Engineering, while by no means strong yet, is showing signs of revival, and better times are confidently anticipated. The finished steel trades, on the other hand, are not satisfactorily situated. Here, the work is very unevenly distributed, and while some firms are quite busy, others report an actual falling off of work. In the aggregate, these lighter branches of the steel trade, which are interested in the better grades of steel, are probably worse off than they were at the beginning of the year. Firms having connections with France, Italy and Belgium are suffering from depreciation of the franc, which has followed the occupation of the Ruhr. Those supplying other markets are better off for trade. Some crucible steel furnaces which have been idle for a considerable time are now finding it possible to work several days a week. There is an improvement in the demand for high-speed steel, although the existence of large quantities of surplus war steel precludes the hope of any early return to normal conditions.

The Old Staple Trades.

The past week has seen the placing of but a moderate quantity of new business in the cutlery and plate trades. There was a falling off in activity after the spurt of last year-end, and the recovery of ground is very slow. Stainless table cutlery is still in very good demand, and there is a well-maintained call for spoons and forks, but, apart from these sections, the trades are not by any means well placed. Very little plate and cutlery is being bought in most parts of the country. A very large order for nickel silver tea sets was recently given out by a soap firm, the articles being for presentation to customers in return for coupons. The contract was divided among a number of firms in Sheffield and Birmingham.

Stainless Developments.

New uses are continually being found for stainless iron and steel. The utilisation of rustless iron for castings has made considerable progress of late. It was formerly thought that this material was not applicable to such work, but some very complicated shapes of metals have now been successfully cast. The cost of these goods is not excessive, and the development promises to open up a new and important field of trade. Another suggested new industry is that of stainless steel candelabra and similar articles. Dr. Hatfield last week, in a lecture to the Cutlery Trades' Technical Society exhibited a number of small and intricate stainless steel castings which have recently been made in the Brown-Firth laboratory, among them a pair of candelabra of artistic design and very high polish. They are made to hold five candles, or they could, of course, be so designed as to take electric light globes. They had not previously been shown in public, and they created a great impression on those who saw them. Among the other castings exhibited were tubes and malleable sheets of stainless steel, in addition to a fine example of stainless steel wire rope. Castings are proving a great success for bearings that have contact with superheated steam.

Tunnelling the Humber.

The commercial men of Hull are actively pursuing their campaign in favour of the construction of a tunnel under the Humber. The Hull Chamber of Commerce recently passed a resolution in support of the scheme, and it is now seeking to influence commercial and general public opinion in the matter. The President of the Chamber has just addressed a circular to over 200 authorities in Yorkshire, Lincolnshire, Derbyshire, Nottinghamshire and Leicestershire, asking them whether they are in favour of the principle of a tunnel for railway traffic, road transport, or both, and whether they will attend a meeting of all interests in favour of the scheme, for the purpose of making representations to the London and North-Eastern Railway Company. The circular points out that the Humber acts as a complete barrier between vast areas of the country, the development of which is retarded by reason of their isolation and lack of means of transport. The present ferry service across the Humber is described as antiquated and inefficient. It is urged that the tunnel is necessary, not only from a local, but also from a national standpoint. New trunk routes from north to south must be opened up. With a Humber tunnel a direct East Coast route from Edinburgh to London would become available,

and, besides relieving the other through routes, would be the means of opening out much territory on this side of the country, which is practically undeveloped. In addition, the time and expense saved in more direct means of transport would be considerable.

LANCASHIRE.

(From our own Correspondents.)

MANCHESTER, Thursday.

General Outlook.

THE iron and metal markets here are in some confusion, and sellers seem very uncertain what prices they ought to be quoting. The effect of the suspension of the industries of the Ruhr Valley is very much greater than was at first expected, and one fears that in the end the result will be very unsatisfactory; although at first we have something like a little boom in iron and metals. The sinister aspect of the case is that this rise in prices is precisely like the rise caused by the outbreak of war. It is not based upon a slowly improving trade, but upon the suspension of vastly important industries; and the reaction is very likely to be similar to the reaction from war conditions. Prices are going up at a time when all the energies of the world ought to be bent upon the work of getting costs down.

Metals.

There has been a further and rather sharp rise in metals, and some consumers now appear to be rather nervous with regard to the future. It is, however, felt that the markets are going rather too fast to be safe, for the actual improvement in trade is not at all proportionate, and the speculative element is too prominent. With regard to copper, of course, the level of prices has been low for a long time, and a slight improvement in consumption would justify a rise. At the time of writing the upward movement in standard copper since the end of January amounts to about £6 per ton, and this is probably enough to produce some profit taking by the earlier speculators. Whether this will be sufficient to check any further rise remains to be seen, but it is probable that the speculative fever is not yet over. The question is whether the actual small improvement in trade is sufficient to justify any further "bull" speculation. The impetus towards higher prices in the copper market seems to have come originally from America, and the copper interests there are apparently set upon raising prices to a higher level. If they succeed in getting electrolytic copper up to £80 per ton here will they be satisfied? After all, such a level for refined copper is not high, for the price will still be low in comparison with the present level of prices in iron, lead and spelter. One notices that manufacturers have not been slow to put up the home prices for sheets, tubes, &c. Strong sheets have been raised to £100 per ton, and brass and copper tubes have been advanced by another ½d. per pound. For export to India, however, copper 4ft. by 4ft. "braziers" are still offered at £88 per ton, so that sheets and copper bottoms at £100 to £110 per ton respectively are obviously dearer than they need to be. The prices for scrap non-ferrous metals are rather higher, but dealers are not raising their prices in full proportion to those in the metal market, and it still pays very well to use scrap metals whenever possible. The upward movement in tin carried the price over £200 per ton, so that the long-delayed anticipation of this price has been fulfilled at last. The further strength in the tin market is again caused by persistent American buying. American buyers seem determined to secure larger supplies of tin, and do not appear to care about the price; but when this demand is satisfied one does not see that the European demand is likely to be big enough to sustain the market. Lead has again been very firm, and English metal has exceeded £30 per ton, while foreign lead is not far off this price. Consumers here, however, seem to be rather nervous about following the market. Spelter is inclined to advance in sympathy, and the galvanisers are buying more freely, but the upward movement is small at present.

Pig Iron.

The market for pig iron is very much disturbed, and sellers are uncertain as to what they ought to do. That there will be a scarcity of iron unless more furnaces can be brought into operation is not at all improbable, and the difficulty of increasing the supply is that blast-furnace fuel is not being made in sufficient quantity to satisfy both the home and the export market. The longer the delay in getting the German iron and coal trade into order again the greater is the probability of a shortage in pig iron here. Some curious things are happening, among them being the dispatch of pig iron from the Midlands to the North Yorkshire districts. As the consumers in those districts are paying up to 115s. per ton for common iron, and the prices last week in the Midlands were only 92s. 6d. to 95s. per ton at the furnaces, it is easy to see that the drain on the Midland district will go on until Cleveland can make enough iron both for export and for local use. This, of course, means that the supply of foundry iron to the Manchester foundries will be interfered with; and, indeed, at the present moment it is quite impossible to say at what price Derbyshire makers would be willing to contract for supplies to Manchester over the next three months. On the other hand, consumers here are sceptical as to the continuance of the present conditions, and rather unwilling to follow the market. Most Midland makers seem now to be aiming at about 100s. per ton at the furnaces; but as our readers know, most of the foundry iron now being used in Manchester has cost only about 82s. 6d. per ton at the furnaces, and it is impossible to contend that the state of the foundry trade has improved to such an extent as to justify this enormous difference. It is, however, true that some buyers here are beginning to be alarmed at the appearance of the market, and may be induced to pay the higher prices.

Steel.

There is no great change here in the market for manufactured steel. The higher costs of fuel and steel-making pig iron are rather inconvenient, but in Manchester the prices for plates and sections are already higher than in some other districts, and until those districts move to the same level there is not any room for advancing prices here. The Midland steel works generally want £10 10s. per ton for plates, and £10 to £10 5s. for sections.

Scrap.

The market for scrap is much stronger. Steel melting scrap is scarce and up to 80s. or perhaps a little over is quoted in Lancashire. Cast scrap is firmer on the stiffness of pig iron prices, and some dealers are now trying for 95s. per ton. Heavy wrought scrap is at 85s. to 87s. 6d. per ton.

Institution of Electrical Engineers.

The North-Western Centre of the Institution of Electrical Engineers held its annual dinner on Friday, 23rd ult, at the Midland Hotel, Manchester. It was a pronounced success from every point of view. Mr. A. S. Barnard, the chairman of the Centre, presided, and was supported by a number of well-known men, including Mr. W. Clare Lees, President of the Manchester Chamber of Commerce; Sir Henry Miers, D.Sc., Vice-chancellor of the University of Manchester; Mr. F. Gill, President of the Institution of Electrical Engineers; Mr. George Hughes, C.B.E., Alderman W. Walker, and Dr. S. Z. de Ferranti. In proposing the toast of "The City and Trade of Manchester," Dr. Ferranti said that Manchester trade was suffering from the want of foreign markets and the laws of some of our Colonies were such that preference designed to favour this country worked out to the benefit of our continental rivals. He said he believed in the system by which England bought food from the Colonies and paid for it by exporting her manufactured goods, but the outlook was not so satisfactory in the future when the Colonies would manufacture these goods themselves. In reply, Mr. Clare Lees spoke chiefly on the unsatisfactory condition of the cotton trade, 80 per cent. of the products of which, he said, were exported. He said that the main cause of the bad trade of Lancashire at present was the disturbed state of Europe, through the failure of the direct market and indirectly through India, which formerly paid for part of what she bought from this country by exports to the Continent. Mr. F. Gill, in replying to the toast of "The Institution of Electrical Engineers," said that one of the problems of the Council at the present time was that of the growth of the Institution, which now had 10,600 members, one-half of which number was catered for by local centres. The toast of "The Guests" was proposed by Alderman W. Walker, and responded to by Mr. George Hughes.

Proposed Colloid Laboratory for Manchester.

The Council of the Manchester University has decided upon a scheme for the provision of a colloids research laboratory and a sum of over £11,000 has been subscribed and given to the University towards the endowment and cost of its equipment. Mr. D. C. Henry, M.A., has been appointed Lecturer in Colloid Physics, to commence in September next, and he will also take charge of the laboratory.

Mid-Lancashire Electricity Scheme.

The inquiry by the Electricity Commissioners into the needs of the mid-Lancashire area came to an end at Preston on Monday last in a compromise. The scheme adopted provides for the formation of a Committee to be called the Mid-Lancashire Electricity Committee, in which the areas governed by the following local authorities will be represented:—The county boroughs of Blackburn, Preston, Burnley, and Blackpool; the municipal boroughs of Accrington, Becup, Chorley, Clitheroe, Colne, Darwen, Haslingden, Lytham St. Annes, Nelson, and Rawtenstall; urban districts about twenty in number, and rural districts six in number. In addition, the London, Midland and Scottish Railway Company will have one representative, the Chambers of Commerce of Preston and Blackburn jointly one, the Cotton Spinners' and Manufacturers' Association, the Lancashire Power Company, and the Lancashire County Council one representative each. This large Committee will appoint an Engineering Committee consisting of the borough electrical engineers of Blackburn, Blackpool, Preston, Accrington, and Rawtenstall; the electrical engineers to the Lancashire Power Company and the London, Midland and Scottish Railway, to give advice and assistance. A space of two years is permitted to give effect to the scheme, and it has been agreed that the following stations shall be closed down:—Bispham, Blackburn (Jubilee-street), and Blackpool and Fleetwood tramways station. As soon as the Ribble station is in operation the Preston (Crown-street) and Deepdale stations are also to be closed. The generating stations at Colne, Darwen and St. Annes will not be further extended unless otherwise determined. A new generating station will be erected when and as required in the neighbourhood of Burnley by the Lancashire Electric Power Company. Main transmission lines will be laid between Preston (Ribble) and Blackburn (Jubilee-street); Blackburn (Whitebirk) and Accrington; Burnley and Nelson; and Blackpool and St. Annes.

The Engineering Trades.

Although so very slowly as to be scarcely perceptible, the engineering industry continues to make improvement. This is borne out by the remarks of Mr. Louis E. Mather, the chairman of the firm of Mather and Platt, Limited, at the annual general meeting of shareholders, held on Tuesday last. Speaking on trade prospects, Mr. Mather said inquiries at home were more numerous than for some time past, although competition was very keen. What is perhaps more satisfactory is that the firm's outlook abroad is "quite hopeful." Mr. Mather said in some sections of the firm's business the firm had done well in France; in India, although the textile trade is dull, orders for other engineering work are coming in well; trade relations have been re-established with Poland; the Far East continues to be a useful market; and from Australia there are encouraging reports. Last, but by no means the least important, Mr. Mather reports that in Russia the situation seems to be slowly changing for the better. There are unfortunately not many engineering concerns in this district who are able to present such a satisfactory report for the past year as that over which Mr. Mather presides, and the shareholders have every reason to be satisfied with a dividend of 10 per cent. and bonus of 5 per cent., both free of income tax. These satisfactory results are attributed to the large amount of work turned out, to the reduction in the cost of materials, lower wages and salaries, careful buying and good selling organisation. The policy of introducing piecework wherever possible—and that at rates yielding substantial benefits to the workers—and the help of works committees are other factors in the success attained at Park Works.

BARROW-IN-FURNESS, Thursday.

Hematite.

There are plenty of orders for hematite pig iron, and the fact of the matter is there is not sufficient iron to satisfy the demands. This condition has been brought about by the shortage of coke. This district is not getting all the coke it requires by about a thousand tons, and the result is some furnaces have to be temporarily damped down whilst others are restricted in their output. It is a serious state of affairs which has been taken up locally, and the Barrow Council has passed a resolution protesting against the shipment of coke to the Continent in such quantities as to limit the activities of local works. Both the home and continental trade is busy and inquiries are considerable.

Iron Ore.

The iron ore trade continues to show life, but the stoppages of furnaces are effecting the output, for there is not the same amount required. Foreign ore is being dealt in in moderate quantities, but as soon as the stocks are cleared there will be more importation.

Steel.

In the Barrow district the steel works are engaged and the rail mills have work for some time. The hoop and bar mills are also fairly employed. Foundries are moderately engaged. In Workington the shortage of coke, having resulted in the reduction of smelting, has led to the stoppage of the steel works for the time being.

NORTH OF ENGLAND.

(From our own Correspondent.)

Trade Expansion Held Up.

TRADE expansion in the North of England is being held up by the present acute shortage of fuel, and in the iron and allied trades conditions are becoming increasingly difficult day by day. The fundamental trouble is the scarcity of blast-furnace coke, which is not only preventing pig iron producers re-starting more furnaces, but is actually compelling some firms reluctantly to curtail output. So serious has the situation become that the men employed on the pig iron refinery plant at the Seaton Carew Ironworks are under a week's notice to terminate their engagements. Relief to the present unfortunate position cannot be expected so long as the phenomenal export demand for coke continues as the result of the French occupation of the Ruhr Valley. There is an insistent demand for fuel from the Continent. The export market price is so much higher than the industrial market at home that coke makers are naturally taking advantage of it for their own benefit, and undoubtedly local industries are very considerably pinched. Coalowners are not withdrawing supplies contracted for in the home trade, but the increased supplies demanded because of the slightly increased trade are not forthcoming.

Cleveland Iron Trade.

With production restricted on account of the shortage of fuel, pig iron prices continue steadily upward. Every effort is being made to increase the output of pig iron so as to overtake the pressing demand for iron both at home and abroad, but developments in this direction are hampered by the lack of fuel, and only firms with their own coke ovens can contemplate putting any more furnaces into blast. Ironmasters dependent upon the purchase of coke in the open market are absolutely prevented from putting any more furnaces into commission and, in fact, are subjected to the utmost anxiety about the regular maintenance of the flow of fuel to the existing furnaces. Of the current make of iron there is practically none for disposal. Ironmasters have filled their order books to the end of April, and only an occasional spot lot comes on the market. It is reported that American makers, attracted by the high prices, have commenced to compete for pig iron orders in Italy, and if this be so it should tend to impose a check on the rise in prices. At the same time it is well to remember that even yet the bulk of the iron leaving Cleveland district was sold at 90s. to 100s. per ton, before the rise took place, and only a very small proportion of the current make has realised recent high prices. On the other hand, makers' costs have risen to great heights and they have reaped no benefit from the rise. As much as 120s. has been paid this week for No. 3 G.M.B. Cleveland pig iron, and on this basis No. 1 becomes 125s., No. 4 foundry 115s., and No. 4 forge 110s. to 112s. 6d.

Hematite Pig Iron.

There is also a marked scarcity of hematite pig iron. Makers are heavily sold, and have practically no more to sell until May delivery. The general quotation for mixed numbers is 115s., but a rather big sale has been put through this week at 112s. 6d. per ton, prices being regulated by the state of the individual makers' books.

Iron-making Materials.

The foreign ore market is quiet again after a period of active business, but prices are steady, 25s. per ton c.i.f. being a seller's price for best Rubio ore, with business reported at 24s. 9d. Coke sellers quote 37s. 6d. per ton as a minimum for good medium furnace qualities delivered at the works.

Manufactured Iron and Steel.

A very active demand has set in for manufactured and semi-manufactured steel and manufacturers are simply deluged with inquiries, particularly for the Continent. It would appear that a few orders are coming here in consequence of the dislocation caused by the Ruhr occupation, but the number is not large, and makers are well able to cope with all the business offering. An all-round advance of 10s. to 20s. is announced in steel prices on the North-East Coast, but the rise is proportionately less than in other areas and by no means covers the extra cost of production. Billets are up 19s. per ton, soft billets now being £9 10s., medium £10, and hard £10 5s. Steel boiler plates are £1 dearer at £14, and steel ship plates, angles and joists are 10s. up, plates being quoted £10, and angles and joists £9 10s. Heavy steel rails remain at £9 10s., and steel fish-plates at £13 10s., whilst common iron bars are quoted £11, galvanised corrugated sheets £19 5s., and black sheets £13 10s. These prices are solely for works on the North-East Coast, and for more distant works the extra cost of transport is added.

The Coal Trade.

The boom in the Northern coal trade continues without any apparent prospect of anything like a break, or even a slight easement, for the next few months at least. But, on the other hand, the upward rush of prices, occasioned by an almost unprecedented demand from the Continent, has been so sudden that many regard the present position as purely fictitious and not likely to last for very long. However that may be, there is no gainsaying the fact that prices are still on the rise and, so far as they can be observed, may even go much higher than they are now. The demand from abroad shows no indication at present of slackening off. The call from Germany is still very heavy, and will continue so long as the French occupation of the Ruhr Valley interferes with and retards coal output. Then from other continental buyers the prospects are that there will be a growing demand as the present year advances. The most responsible people in the coal trade view with deep regret and concern the present boom, as being likely to cripple the home industrial recovery in the iron and steel trades on which the prosperity and well-being of this country so largely depends. Some of the shippers look with hope to the advent of American competition in the European market to reduce the Northern market to something more like a natural and economic level than prevails at present. There is no doubt that this competition is beginning to take practical shape, and this week several firms report that best American coking coals have been offered to them in large quantities for shipment in the next few months at 39s. per ton c.i.f., with the entire West European range of options. This competition, now that it is in operation, will have some tangible effect. If present prices, or higher ones, are to remain in operation, coupled with a rising freight market, there is presented a splendid opportunity for successful competition on the part of American coal producers. The Northumberland steam coal section has become exceedingly tight and strenuous, with future prospects still hardening. Most of the collieries are sold out and any fortunate holder of supplies is in a position to command any price he likes to demand. Durham gas coals are scarce and strong, while coking is difficult to negotiate on any terms. Bunkers are in keen demand, but not easy to secure. Coke is an exceptionally strong market. All classes of furnace and foundries are up from 5s. to 10s. per ton, as much as 70s. being indicated by some producers for export.

SCOTLAND.

(From our own Correspondent.)

Quieter Activities.

A FAIR amount of activity is still noticeable in industrial circles, but the effect of higher prices is becoming more clearly demonstrated. Buyers show more inclination to hesitate before committing themselves, and the effect of current high levels of prices has been to curtail business to a very considerable extent. High costs of raw materials make increases in finished articles inevitable, but there is now a distinct danger of charges becoming altogether prohibitive again. Therefore, although recent activities promised an increasing improvement, the immediate outlook is not so satisfactory. In the meantime the export markets apparently are not being affected to the same extent as the home ones, owing to the circumstances on the Continent, and local works may reap some benefit therefrom, but home demands have undoubtedly slackened off considerably within the past week or two. Many consider that the present upward tendency is only a temporary one, and that the movement will be speedily arrested, and it is hopefully anticipated that this may be accomplished before trade again descends to the dull conditions so long experienced.

Pig Iron Scarcity.

The demand for pig iron is not excessive, but with the output of such a restricted nature difficulty is experienced in meeting purchasers. Consequently, makers have no trouble in disposing of outputs at full current prices. Some producers are evidently willing to hold to present levels, but others are out for still higher prices, and therefore the last quotations of £5 10s., £5 12s. 6d. and £5 7s. 6d. per ton for hematite No. 1 and No. 3 foundry may have been increased since the time of writing.

Steel and Iron.

The steel works have a comparatively good amount of work on hand, but recent bookings have not been so satisfactory. Orders for shipbuilding material are slower and lighter in bulk, and sectional material is not moving quite so freely. Sheetmakers do not report any change. Sheets are in fair demand, and the export inquiry is more promising. Imported raw materials are very scarce, and home producers are benefiting to some extent. Conditions at the bar iron works are unchanged. Demands from abroad are compensating for any drop in home business. Crown bars remain at £11 per ton for home delivery, and practically a similar figure for export. Re-rolled steel bars are in good demand for export, the price being about £9 10s. per ton f.o.b., with the home quotation 5s. per ton more. Some encouraging reports are to hand of contracts booked for abroad, and in this connection an order secured by Stewarts and Lloyds, may be mentioned. This contract is for the supply of 37 miles of steel pipes for the British Controlled Oilfields, for the new pipe line to be laid to convey oil from the company's oil wells at El Meme, Venezuela, to Altagracia.

Coal.

There has been practically no easing of the export demands for Scotch coal, and the market shows still further strength. Supplies for prompt loading are very quickly taken up at current prices, and some comparatively good orders have been booked for delivery over the next two months at even higher quotations. Lanarkshire ells, splints and navigations are moving freely, and shipments are fairly regular. Fifeshire steams, too, are well booked and Lothian steams busily employed. The pressure for washed materials, however, has been the feature during the past few days, and these are now in very short supply, while prices have appreciated considerably. The aggregate shipments for the week amounted to 305,263 tons, against 325,113 tons in the preceding week and 210,700 tons in the same week last year. In the home market, industrial demands continue slow, but regular deliveries are going to municipal concerns and household requirements are steady.

Longer Working Week.

By a curious turn of events it is reported that the Lanarkshire Miners' Union agreed at a special conference to recommend the adoption of the eleven days per fortnight working policy. This decision was greatly influenced by Mr. Robert Smillie, who during the greater part of his lifetime has been a firm supporter of the shorter week. Further, it has been stated that the decision was also influenced by the fact that some collieries, besides already working six days per week, were also at work on Sundays.

WALES AND ADJOINING COUNTIES.

(From our own Correspondent.)

Coal Trade Position.

SINCE writing a week ago there have been interesting developments in the coal trade situation. The German demand has become more pronounced, and it is estimated that at least half a million tons of coal have been purchased from this district for shipment during the next few weeks, in addition to which considerable quantities of coke have also been booked. On paper, collieries are well sold for some time ahead, and as a consequence their ideas as to prices for further quantities are rather elevated, but these may receive a check, inasmuch as America has entered the arena once more and is competing for European business. It was thought that America could be ignored so far as the export business was concerned, but America has considerable quantities of highly bituminous coals that she can dispose of, and these are to a large extent the class that Germany requires. As a matter of fact, it is reported that already Germany has placed orders for American coal, and that altogether cargoes aggregating between 50,000 and 70,000 tons have been arranged for German, Belgian and Italian ports. Offers were recently received of American coal at rather more than 30s. per ton, c.i.f. Rotterdam, which compares very favourably with the price at which Welsh coals can be supplied. Best Welsh Admiralty large is at present quoted at 32s. 6d. f.o.b., while on the basis of good through coals the Americans can run Welsh exporters very close, but what is of paramount importance to German and other European buyers of coal is the fact that this country is not able to supply much, if any, more coal than has been arranged during the next month or so. If the dock accommodation and the working hours in South Wales ports were equal to dealing with abnormal conditions, there is no doubt that considerably more business would have come to this district. There would have been no need for European buyers to have gone to America for coals. The extent of the German demands alone have had a disturbing effect upon not only the coal market, but the freight market also. Steamers running up to 8000 tons have been chartered for Hamburg and other ports, and the sudden inquiry for prompt steamers has caused quite a sharp rise in rates for practically all directions, to the dismay of those exporters who have c.i.f. commitments and who can see anticipated profits melting away as they have to pay higher rates for suitable tonnage for the North French, Bay and Mediterranean ports.

Dock Working Hours.

All associated with the coal export trade are hoping that it will not be necessary for the question of an extension of dock working hours to be submitted to a court of arbitration, and that the parties will find a way out as the result of negotiation, as this is believed to be the quicker method of finding a solution of the difficulties now being experienced at the various ports. The result of the conference at the office of the Ministry of Labour in London on Tuesday was keenly looked for. The fact that the men's leaders agreed at the end of last week to accept the invitation of the Ministry to meet representatives of the employers was regarded as a good sign, more especially as it was understood that there was a prospect of the men's leaders putting forward fresh proposals in regard to the terms under which they will agree to work a third shift.

Miners' Wages.

According to a statement by the Secretary of the South Wales Coalowners' Association, the past practice in the regulation of wages under the national agreement of June, 1921, has been for the audit of the proceeds and costs for one month to govern the general wage rate in the month next but one following. Under a recent decision of the National Board, it was mutually agreed by the employers and the workmen that the wages in March and April should be determined by the proceeds of the industry in November and December. The audit under this arrangement has now been announced, and the certificate of the joint accountants for those two months has been received. It states that after allowing for the cost of the standard wages, other costs and the owners' standard profits, the surplus available is £313,267. This surplus is only enough to enable the auditors to certify a general wage rate of 13.73 per cent. on the 1915 standard rates, compared with the 16.09 per cent. payable in January and February. Under the terms of the national agreement, however, the owners have to pay a minimum wage of 28 per cent. on the 1915 standard rates, and the difference has to be made up by the owners sacrificing their standard profits, and over the two months the amount of the standard profits sacrificed for this purpose is £471,786. This brings the total amount sacrificed by the owners under the minimum wages clause since November, 1921, to £3,338,400.

Non-Unionism.

It looked very much from the statement of one of the miners' leaders at the end of last week as if there would be a marked extension of idleness in the coalfield in pursuance of the campaign against the non-unionists. Last week there were about 2000 idle at the Bargoed House Coal Colliery and the Groesfaen Colliery in the Rhymney Valley. It was complained that the officials of the company had interfered with the miners in examining the cards of the workmen, and it was therefore proposed to lay the whole matter before the miners throughout the Valley. As a result, it was feared that instead of 2000 men being idle, the figure would be nearer 20,000, but as matters turned out over the week-end, it was reported that the defaulters were joining the Federation, and therefore the miners at the Bargoed House Coal Colliery and the Groesfaen Colliery decided to return to work.

Current Business.

There has been a very active demand from all directions during the past week, and both large and small coals have advanced. As a matter of fact, collieries have as many orders upon their books as they can well entertain for the next few weeks, and in some instances they are fully sold for the next six weeks or two months. Unfortunately, while they are in a comparatively strong position, the bad weather has caused tonnage to be delayed, and steamers are not coming to hand to time, which is causing considerable dislocation of their arrangements. At the same time, best Admiralty large are firmly quoted for delivery ahead at 32s. 6d. and second qualities at 30s. to 31s. Steam small coals have shown a marked advance, and are up to 25s. for the best, while coking qualities are practically unobtainable. There has also been a phenomenal rise in the price of coke, which a fortnight ago was quoted at 45s. to 50s. Collieries are now fully sold. At the end of last week business was done at 70s., while now the price is 80s., but this is almost a nominal figure, as makers have little or none to spare.

Latest News from the Provinces.

NORTH OF ENGLAND.

Big Gas Coal Contracts.

THE London gas companies have contracted for large quantities of Durham gas coals on very favourable terms, having regard to the present difficult market conditions. The deliveries are from March to the end of December next. The South Metropolitan Gas Company has contracted for about 1½ million tons, and the Gas Light and Coke Company has bought about 2 million tons of various kinds. The prices in all cases are understood to range from 22s. 6d. to about 24s. 6d. per ton f.o.b.

WALES AND ADJOINING COUNTIES.

Dock Hours.

The conference in London on the question of the extension of working hours at South Wales docks has been adjourned until Wednesday next, when the parties will continue discussions at Cardiff.

Non-Unionism.

The prospects of a resumption of work at Nine Mile Point collieries, where the non-unionist dispute is in operation, are not bright. The horses have been brought up and this points to a continuation of the stoppage. About 2000 men are affected. In the case of the trouble at the Bargoed House Coal Colliery and the Groesfaen Steam Coal Colliery, the workmen commenced work on Tuesday.

Swansea Metal Exchange.

The tin-plate market is strong, and there is every prospect of prices going higher. Block tin is advancing, as well as other costs, and it is calculated that the increase in tin alone works out at an additional cost to manufacturers of 4½d. per box. Business has been done up to 22s. per box basis I.C., f.o.b., and it is regarded as likely before long that the price of 23s. will be obtainable.

Current Prices for Metals and Fuels.

IRON ORE.

N.W. COAST—	
Native	22/6
(1) Spanish	21/6
(1) N. African	21/6
N.E. COAST—	
Native	—
Foreign (c.i.f.)	25/-

PIG IRON.

	Home. £ s. d.	Export. £ s. d.
(2) SCOTLAND—		
Hematite	5 17 6	—
No. 1 Foundry	6 0 0	—
No. 3 Foundry	5 15 0	—
N.E. COAST—		
Hematite Mixed Nos.	5 15 0	5 15 0
No. 1	5 16 0	5 16 0
Cleveland—		
No. 1	6 5 0	6 5 0
Silicious Iron	6 2 6	6 2 6
No. 3 G.M.B.	6 0 0	6 0 0
No. 4 Foundry	5 15 0	5 15 0
No. 4 Forge	5 12 6	5 12 6
Mottled	—	—
White	—	—
MIDLANDS—		
(3) Staffs.—		
All-mine (Cold Blast)	13 0 0	—
North Staffs. Forge	4 12 6	—
,, ,, Foundry	4 10 0	—
(3) Northampton—		
Foundry No. 3	4 15 0	—
,, Forge	4 10 0	—
(3) Derbyshire—		
No. 3 Foundry	4 15 0 to 5 0 0	
Forge	4 10 0	—
(3) Lincolnshire—		
Basic	5 5 0 to 5 10 0	
Foundry	4 10 0 to 5 0 0	
Forge	4 5 0 to 4 10 0	
(4) N.W. COAST—		
N. Lancs. and Cum.		
Hematite Mixed Nos.	6 2 6 to 6 5 0	

MANUFACTURED IRON.

	Home. £ s. d.	Export. £ s. d.
SCOTLAND—		
Crown Bars	11 0 0	10 10 0
Best ,,	12 0 0	—
N.E. COAST—		
Crown Bars	12 0 0	—
Tees	10 0 0	—
LANCS.—		
Crown Bars	12 0 0	—
Second Quality Bars	11 5 0	—
Hoops	15 0 0	14 15 0
S. YORKS.—		
Crown Bars	12 0 0	—
Best ,,	12 10 0	—
Hoops	15 0 0	—
MIDLANDS—		
Crown Bars	11 10 0	—
Marked Bars (Staffs.)	13 10 0	—
Nut and Bolt Bars	10 15 0 to 11 0 0	
Gas Tube Strip	11 15 0	—

STEEL.

	(6) Home. £ s. d.	(7) Export. £ s. d.
(5) SCOTLAND—		
Boiler Plates	12 0 0	—
Ship Plates ¼in. and up	9 5 0	—
Sections	9 0 0	—
Steel Sheets ¼in. to ⅛in.	11 10 0	—
Sheets (Gal. Cor. 24 B.G.)	—	19 10 0

STEEL (continued)

	Home. £ s. d.	Export. £ s. d.
N.E. COAST—		
Ship Plates	10 0 0	—
Angles	9 10 0	—
Boiler Plates	14 0 0	—
Joists	9 10 0	—
Heavy Rails	9 10 0	—
Fish-plates	13 10 0	—
Channels	9 5 0	—
Hard Billets	10 5 0	—
Soft Billets	9 10 0	—
N.W. COAST—		
BARROW—		
Heavy Rails	9 10 0	—
Light ,,	10 10 0 to 11 0 0	
Billets	9 0 0	—
MANCHESTER—		
Bars (Round)	9 0 0 to 9 10 0	
,, (others)	9 10 0 to 10 0 0	
Hoops (Best)	14 15 0	14 15 0
,, (Soft Steel)	12 15 0	12 10 0
Plates	9 0 0 to 10 0	
,, (Lancs. Boiler)	13 10 0	—
SHEFFIELD—		
Siemens Acid Billets	11 0 0	—
Bessemer Billets	12 10 0	—
Hard Basic	10 5 0	—
Intermediate Basic	10 0 0	—
Soft Basic	9 0 0	—
Hoops	12 15 0 to 13 0 0	
Soft Wire Rods	11 0 0 to 11 10 0	
MIDLANDS—		
Small Rolled Bars	10 0 0 to 10 10 0	
Billets and Sheet-bars	8 10 0 to 9 0 0	
Gas Tube Strip	10 5 0 to 10 10 0	
Sheets (20 W.G.)	11 10 0 to 12 0 0	
Galv. Sheets (f.o.b. L'pool)	19 0 0 to 19 10 0	
Angles	10 0 0	—
Joists	10 0 0	—
Tees	11 0 0	—
Bridge and Tank Plates	10 5 0 to 10 10 0	

NON-FERROUS METALS.

SWANSEA—	
Tin-plates, I.C., 20 by 14	21/9 to 22/-
Block Tin (cash)	201 5 0
,, (three months)	203 0 0
Copper (cash)	72 2 6
,, (three months)	72 17 6
Spanish Lead (cash)	29 7 6
,, (three months)	28 17 6
Spelter (cash)	37 0 0
,, (three months)	37 0 0
MANCHESTER—	
Copper, Best Selected Ingots	76 0 0
,, Electrolytic	80 0 0
,, Strong Sheets	102 0 0
,, Loco Tubes	0 1 2
Brass Loco Tubes	0 1 0½
,, Condenser	0 1 1½
Lead, English	30 10 0
,, Foreign	29 10 0

FERRO ALLOYS.

(All prices now nominal.)

	Per Ton.	Per Unit
Tungsten Metal Powder	1/11 per lb.	
Ferro Tungsten	1/5 per lb.	
Ferro Chrome, 4 p.c. to 6 p.c. carbon	£23	10/-
,, 6 p.c. to 8 p.c. ,,	£21 0 0	8/-
,, 8 p.c. to 10 p.c. ,,	£20 0 0	8/-
,, Specially Refined		
,, Max. 2 p.c. carbon	£54 0 0	20/-
,, ,, 1 p.c. ,,	£64 0 0	22/6
,, ,, 0·75 p.c. carbon	£72 0 0	25/-
,, carbon free	1.6 per lb.	
Metallic Chromium	4/6 per lb.	
Ferro Manganese (per ton)	£15 for home.	
,, Silicon, 45 p.c. to 50 p.c.	£11 15 0 scale 5/- per unit	
,, ,, 75 p.c.	£20 0 0 scale 6/- per unit	
,, Vanadium	17/- per lb.	
,, Molybdenum	9/- per lb.	
,, Titanium (carbon free)	1/2 per lb.	
Nickel (per ton)	£130	
Cobalt	11/- per lb.	
Aluminium (per ton)	£82 to £100 (British Official.)	

FUELS.

SCOTLAND.	Export.
LANARKSHIRE—	
(f.o.b. Glasgow)—Steam	27/-
,, ,, Ell	27/6
,, ,, Splint	29/- to 35/-
,, ,, Trebles	28/-
,, ,, Doubles	27/6
,, ,, Singles	27/-
AYRSHIRE—	
(f.o.b. Ports)—Steam	27/-
,, ,, Splint	29/-
,, ,, Trebles	28/-
FIFESHIRE—	
(f.o.b. Methil or Burntisland)—Steam	30/- to 32/6
Screened Navigation	35/-
Trebles	28/-
Doubles	27/6
Singles	27/-
LOTHIANS—	
(f.o.b. Leith)—Best Steam	28/6
Secondary Steam	27/6
Trebles	28/6
Doubles	27/6
Singles	27/-

ENGLAND.	
(8) N.W. COAST—	
Steams	29/-
Household	46/8 to 57/6
Coke	36/-
NORTHUMBERLAND—	
Best Steams	32/6 to 35/-
Second Steams	27/6 to 30/-
Steam Smalls	20/- to 25/-
Unscreened	20/6
Household	25/- to 28/-
DURHAM—	
Best Gas	33/- to 35/-
Second	30/-
Household	25/- to 28/-
Foundry Coke	70/- to 80/-

SHEFFIELD—	INLAND.
Best Hand-picked Branch	32/6 to 34/6 —
Barnsley Best Silkstone	28/- to 30/- —
Derbyshire Best Brights	25/6 to 27/6 —
,, ,, House	23/- to 24/6 —
,, ,, Large Nuts	20/6 to 22/6 —
,, ,, Small ,,	15/- to 16/6 —
Yorkshire Hards	21/- to 22/- —
Derbyshire ,,	20/- to 21/- —
Rough Slacks	10/- to 12/- —
Nutty ,,	8/- to 10/- —
Smalls	3 - to 5/- —
Blast Furnace Coke (Inland and Export)	24/- to 30/-

CARDIFF— (9) SOUTH WALES.	
Steam Coals:	
Best Smokeless Large	31/- to 32/6
Second ,, ,,	30/- to 31/-
Best Dry Large	28/6 to 30/-
Ordinary Dry Large	27/- to 28/-
Best Black Vein Large	30/- to 31/-
Western Valley ,,	30/- to 31/-
Best Eastern Valley Large	30/- to 31/-
Ordinary ,, ,,	29/- to 30/-
Best Steam Smalls	24/- to 25/-
Ordinary ,,	20/- to 22/6
Washed Nuts	27/6 to 30/-
No. 3 Rhondda Large	30/- to 31/-
,, ,, Smalls	24/6 to 25/-
No. 2 ,, Large	27/6 to 30/-
,, ,, Through	23/6 to 26/-
,, ,, Smalls	20/- to 22/6
Coke (export)	70/- to 80/-
Patent Fuel	35/- to 37/6
Pitwood (ex ship)	27/6 to 28/-
SWANSEA—	
Anthracite Coals:	
Best Big Vein Large	35/- to 40/-
Seconds	30/- to 35/-
Red Vein	27/6 to 28/6
Machine-made Cobbles	40/- to 45/-
Nuts	50/- to 52/6
Beans	45/ to 47/6
Peas	20/- to 22/-
Breaker Duff	11/- to 12/-
Rubbly Culm	14/- to 15/-
Steam Coals:	
Large	27/- to 28/-
Seconds	24/- to 26/-
Smalls	16/- to 17/-
Cargo Through	19 6 to 23/-

(1) Delivered. (2) Net Makers' works. (3) At furnaces. (4) Delivered Sheffield. (5) Glasgow, Lanarkshire and Ayrshire

(6) Home Prices—All delivered Glasgow Station. Boiler Plates 10/- extra delivered England. (7) Export Prices—F.O.B. Glasgow.

(8) Except where otherwise indicated coals are per ton at pit for inland and f.o.b. for export and coke is per ton on rail at ovens and f.o.b. for export. (9) Per ton f.o.b

French Engineering Notes.

(From our Correspondent in Paris.)

Motor Fuels.

THE problem of substituting locally produced liquid fuels for petrol is likely to occupy two or three meetings of the Société des Ingénieurs Civils, the first of which was devoted last week to papers providing data that will serve as the basis of a general discussion. The interest being aroused in this question is considerable alike amongst engineers and chemists, agriculturists and power users, and perhaps even more amongst the State services which regard the production of home-grown fuels as necessary to the country's existence. Nevertheless, the problem is not so easy of solution as would seem to be implied by the Bill, which has passed through the Chamber of Deputies without discussion, requiring importers of mineral spirit to purchase from the State a quantity of alcohol equal to 10 per cent. of the petrol, benzol, toluene and other spirits purchased abroad. In introducing the question of alcohol as a motor fuel, M. Daniel Berthelot pointed out that there could be no universal substitute for petrol, for while an alcohol mixture could be imposed in an agricultural country like France, it would probably not offer the same economic advantages in purely industrial countries. Yet it was necessary to ensure a standard mixture in this country, which was the reason why the Bill fixed an addition of 10 per cent. alcohol as a means of absorbing the present national production, and it is probable that the percentage will be gradually increased with an augmentation of alcohol output until a proportion is reached which will give the most economical results. Judging from the papers presented at the first meeting there are so many side issues in the problem of power alcohol that a satisfactory solution will only be reached after a long period of chemical research, and by methods of elimination and adaptation of various fuels. Valuable work continues to be done by the Comité Scientifique du Carburant National, of which M. Daniel Berthelot is president, and by the Transports en Commun de la Région Parisienne, which is still carrying out exhaustive tests with all kinds of composite fuels on the Paris motor omnibuses.

Alcohol Mixtures.

The Bill, which has passed through the Chamber of Deputies, aims at doing the only thing possible at the present moment to ensure a practical utilisation of alcohol, and it is also more particularly intended to relieve the State of the huge stocks of alcohol which have been accumulating since it acquired a monopoly of the spirit for power purposes. An element of uncertainty is introduced into the situation by the possibility of the Service of Explosives requiring at any moment very much larger quantities of alcohol, whereby the amounts available for power purposes would be proportionately restricted. It is obvious that the production of spirit from beet, grain, potatoes and other produce cannot be increased indefinitely without necessitating the purchase of foodstuffs from abroad, so that, from an economical point of view, the creation of an alcohol fuel would defeat its own ends. Again, although exhaustive experiments extending over many years have proved that alcohol is a satisfactory constituent of a composite fuel, it is nevertheless clear that a 10 per cent. mixture with petrol will not be generally successful, for the reason that a 95 deg. to 96 deg. alcohol is not entirely soluble in petrol, although the solubility is complete in benzol and some other spirits. As the proportion of alcohol increases the mixture becomes more intimate, and a proportion of 40 to 50 per cent. alcohol to petrol is regarded as quite satisfactory, while alcohol and benzol in equal parts makes a good substitute. If an addition of 10 per cent. alcohol is imposed, however, this can only be done by a process of dehydration which has been carried out successfully on a relatively small scale by the Service of Explosives. Several other methods of dehydration are being experimented with, the results being so far encouraging as to lead to the hope that some of the processes will become commercially practicable. While most of the data available concerning alcohol fuels are due to laboratory tests, they do not appear to be borne out completely by the results of actual running tests on the Paris omnibuses, where almost every conceivable kind of composite fuel has been tried. As the cost of the liquid fuel represents 21 per cent. of the total running costs of the omnibuses, the company is looking closely into this means of realising economies. Before the war it started with a mixture of half alcohol and half benzol, and under the Treaty of Versailles it was expected that the supplies of benzol from Germany would have permitted of this becoming a standard fuel. Nothing else appears to have proved quite satisfactory.

Fuel Costs.

The situation of alcohol becomes still more complicated in view of the necessity of selling the mixture at the same price as petrol for an equivalent output in work. The great argument put forward in favour of the State monopoly of alcohol was that the spirit would be supplied at very low cost for agricultural tractors and lorries, and that the composite fuel would permit of a reduction in the running costs of all motor users. Since the monopoly, however, there has been no decline in the price of alcohol, and an alcohol-petrol mixture costs more than petrol alone, so that the only way of bringing down the price of petrol with a 10 per cent. mixture of alcohol is for the State to sell the spirit at below cost. It is understood that the State intends doing this as a temporary expedient. As a matter of fact, the possibility of supplying alcohol at a sufficiently low price offers so much uncertainty that a discussion always branches off into other substitutes, both as a means of supplementing what will always be a deficient supply of alcohol and as a means of regulating prices. The last few years has seen considerable fluctuations in the prices of these substitutes, and if any one of them were to be adopted as a constituent for a standard national fuel, it is to be presumed that the heavy consumption would increase the cost, unless controlled by the State, which is being done in the case of alcohol.

British Patent Specifications.

When an invention is communicated from abroad the name and address of the communicator are printed in italics.

When an abridgment is not illustrated the Specification is without drawings.

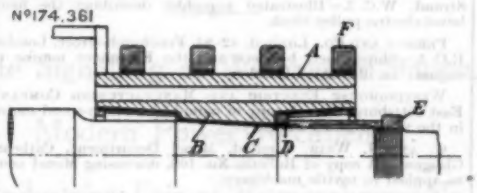
Copies of Specifications may be obtained at the Patent Office Sale Branch, 25, Southampton-buildings, Chancery-lane, W.C., at 1s. each.

The date first given is the date of application; the second date, at the end of the abridgment, is the date of the acceptance of the complete Specification.

DYNAMOS AND MOTORS.

174,361. January 20th, 1922.—THE IMPROVED MOUNTING OF THE COMMUTATORS OF ELECTRIC MACHINES, Siemens-Schuckertwerke Gesellschaft, Siemensstadt.

THE shafts of electrical machines, and especially those with long commutators, are often strained on account of the expansion of the commutator segments. In order to overcome this trouble the inventors support the commutator on the shaft in only one place. The commutator segments A have a narrow projecting

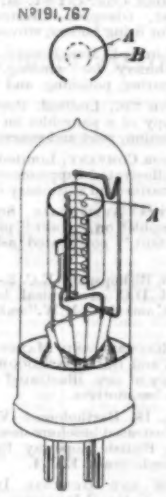


part B, which is short compared with the total length of the commutator, and this part rests on an insulating sleeve C on the shaft, which is made conical as shown. The commutator is held on the shaft by means of a pressure ring D, which is pressed against the segments by means of the screwed ring E. In the radial direction the segments are held together by shrink rings F. —*January* 25th, 1923.

TELEGRAPHS AND TELEPHONES.

191,767. July 16th, 1921.—IMPROVEMENTS IN THE CONSTRUCTION OF THERMIONIC VALVES, Stanley Robert Mullard, of the Mulard Radio Valve Company, Limited, of 35, Claybrook-road, Hammersmith.

It will be seen from the drawing that the grid A of the valve, which is in the form of a zigzag wire, is bent round the axis of the valve, but only partially surrounds the filament. A gap is

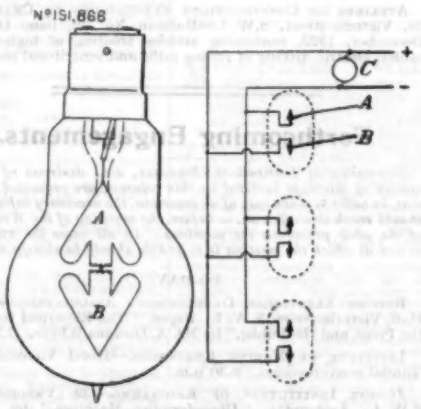


also left in the anode B. Various advantages are claimed for this form of construction. With an open grid, for example, the valve is more easily constructed, and the filament is less liable to sag against the grid.—*January* 16*th*, 1923.

LIGHTING AND HEATING.

191,866. October 28th, 1921.—IMPROVEMENTS RELATING TO ELECTRIC LAMPS OPERATING BY ELECTRIC DISCHARGE, Howard Marryat and Murray Duncan Scott, both of 28, Hatton-garden, London, E.C. 1.

It is known that when lamps of the discharge type are supplied

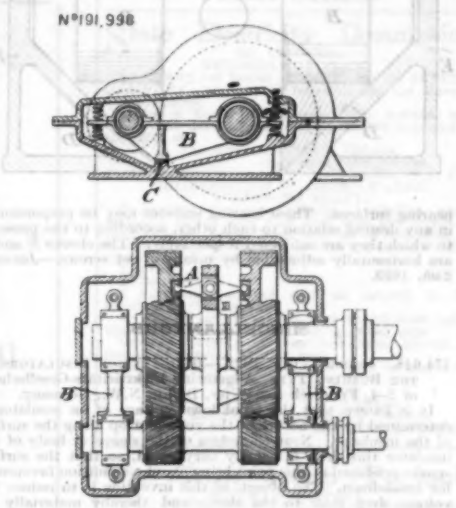


with direct current the major portion of the light emanates from the surface of the cathode, and according to this invention the distinctive electrodes, which may be made in the form of differently pointing arrows, are connected to the armature terminals of a direct-current lift motor, so that one electrode glows when the lift is moved in one direction and the other electrode glows when the current is reversed in order to move the lift in the opposite direction. The principle involved will readily be understood from the diagrams, where the electrodes are marked A and B and the lift motor C.—*January* 25*th*, 1923.

TRANSMISSION OF POWER.

191,996. April 11th, 1922.—REDUCTION GEARING, A. S. Cachemaille, 2, Norfolk-street, Strand, London, W.C. 2.

In this gear the pinion is normal, but the two halves of the gear wheel are mounted loosely on their shaft, to which they are connected by means of a disc and rocking levers A. Both the

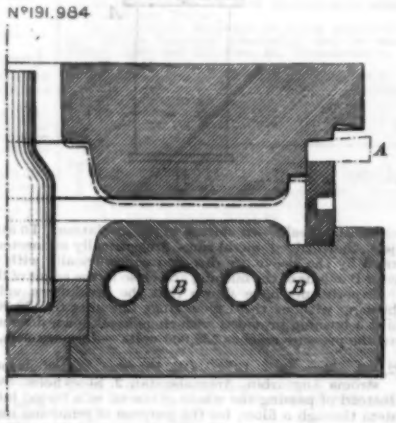


shafts run in bearings that are carried by floating frames B B. These frames are supported each on a fulcrum C in such a position that the moments caused by the torques of the gears are balanced. —*January* 25th, 1923.

TRAMWAYS AND RAILWAYS.

191,984. March 7th, 1922.—STEEL RAILWAY WHEELS, D. Stewart and Co., Limited, London-road Ironworks, Glasgow, and T. E. Holmes.

According to this invention, the wheel is formed in a metal mould having a core for the centre of the hub portion, the mould box, which is in several portions, being so supported by the wedges A during the time the metal is being poured into the box that a greater space is left within the mould than is required for the dimensions of the finished wheel. Into this space ingot metal is poured either to fill or partially to fill it. Then, while the metal



is still in a semi-fluid state, the wedges are removed and pressure is applied to it to compress the still fluid or mobile metal until it occupies the space required for the desired size of the wheel, which is indicated by the broken lines. A portion of the metal may exude during compression from between the parts of the mould box. This portion may be afterwards machined off. A series of cooling coils B B is arranged in the lower part of the mould.—*January* 25*th*, 1923.

WELDING.

191,910. November 30th, 1921.—IMPROVEMENTS IN OR RELATING TO WELDING BY THE ELECTRIC ARC, The Premier Electric Welding Company, Limited, and John Hamilton Paterson, both of Bank Buildings, St. James'-street, London.

The chief object of this invention is to improve the metal of the weld by providing the electrode with a coating which during the welding process produces a reducing atmosphere around the arc and over the heated metal, and this atmosphere, which is usually a mixture of carbon monoxide and dioxide, protects the weld from the action of the air. The coating of the rod of iron or iron alloy comprises a carbonate of a heavy metal, the oxides of which, having a comparatively low melting point, such as iron, nickel or manganous carbonate, together with a proportion of carbon or carbonaceous material, such as ground coke or anthracite. The mixture may be made into a paste with a suitable binding agent and coated upon the electrode. The mixture may consist, for example, of chalk two parts, ferrous carbonate six parts, and lampblack eight parts by weight. The ferrous carbonate may be replaced by equal parts of nickel or manganous carbonate. An alternative mixture is also given.—*January* 25*th*, 1923.

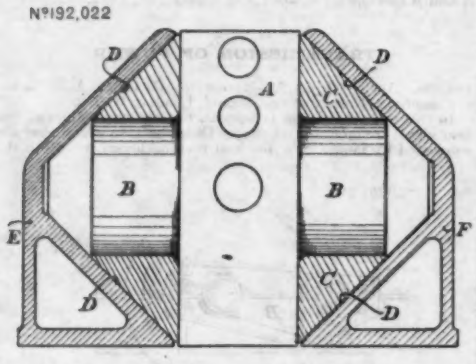
MACHINE TOOLS AND SHOP APPLIANCES.

192,022. July 10th, 1922.—SEMI-AUTOMATIC LATHES, F. R. Deuring, Hohenzollernstrasse 134, Munchen-Gladbach, Germany.

According to this invention the turret A of a semi-automatic

lathe has two gudgeons B whereby it is mounted in the slide C, whose surfaces D are portions of a regular four-sided prism standing upon one of its edges, symmetrical to the horizontal. The slide is embraced by two cheeks E and F, having corresponding

N°192,022



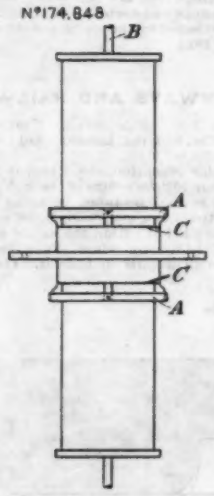
bearing surfaces. These bearing surfaces may be proportioned in any desired relation to each other, according to the pressure to which they are subjected respectively. The cheeks E and F are horizontally adjustable by means of set screws.—*January 25th*, 1923.

MISCELLANEOUS.

174,648. January 20th, 1922.—High-tension Insulators of the Bushing Type, Allgemeine Elektricitäts-Gesellschaft, of 2–4, Friedrich Karl-Ufer, Berlin, N.W., Germany.

It is known that the breakdown voltage of an insulator is determined by the nature of the voltage drop along the surface of the insulator. Near the edges of the sleeve or body of the insulator this drop is usually very rapid, so that the surface sparks produced at this point bring about a condition favourable for breakdown. The object of this invention is to reduce the voltage drop close to the sleeve and thereby materially to

N°174,848

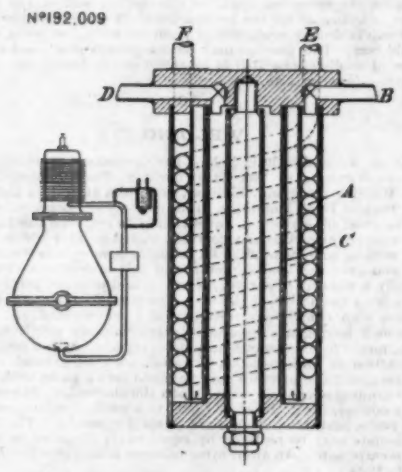


increase the breakdown voltage of the insulation. To attain this object sharp-edged metal rings A electrically connected to and carried by the sleeve are disposed concentrically with the conductor B or axis of the bushing and close to the edges of the sleeve C. Experiments have shown that the breakdown voltage for a bushing without these glow rings amounts to 170,000 volts, whilst a bushing provided with rings breakdown does not occur until the pressure reaches 330,000 volts.—*January 25th*, 1923.

192,009. May 15th, 1922.—Oil Filters, Aktiebolaget Ljungströms Angturbin, Arsenalsgatan 2, Stockholm, Sweden.

Instead of passing the whole of the oil in a forced lubrication system through a filter, for the purpose of removing impurities, the inventors arrange the filter in a by-pass, so that only a portion of the oil flows through it, but at the same time the filter can be

N°192,009



put out of action for cleaning purposes without checking the lubrication system. The filter itself is of the cylindrical type and includes a heating coil A. The oil enters at B, is warmed by the coil in the outer compartment, passes through the filtering medium C, and is discharged back to the lubrication system at D. E and F are the connections for the warming coil.—*January 25th*, 1923.

Catalogues.

Robey and Co., Limited, Lincoln.—Catalogue No. 343, discussing the firm's marine type of crude oil engines.

J. H. Sankey and Son, Limited, Canning Town, and 74, Cheapside, E.C. 2.—Booklet on "Pyruma" fire cement.

Dieny and Lucas, Limited, 329, High Holborn, W.C. 2.—Pamphlet No. 17 giving particulars of three-phase motors.

John Lang and Sons, Limited, Johnstone, near Glasgow.—Catalogue describing the Lang surfacing and boring lathe.

Edward Le Bas and Co., Dock House, Billiter-street, E.C. 3.—Leaflet on Robertson asbestos protected metal roofing, &c.

Royles, Limited, Irlam, near Manchester.—Folder giving illustrations and descriptions of a few of the firm's manufactures.

Stothert and Pitt, Limited, Bath.—Catalogue F6, describing rotary pumps for dealing with viscous and non-viscous fluids.

Charles Hall, 409, Newton-avenue, Milwaukee, Wisconsin U.S.A.—A leaflet describing Hall-Amant boiler setting cement.

Baddon and Arton, 45, Chancery-lane, W.C. 2.—A pamphlet dealing with automatic pump priming and water straining by the Seaborne interceptor.

Medway's Safety Lift Company, Limited, 35, Surrey-street, Strand, W.C. 2.—Illustrated pamphlet describing the firm's latest electric pulley block.

Perman and Co., Limited, 82–83, Fenchurch-street, London, E.C. 3.—Ships, their builders, and the Kromhout marine oil engine; an illustrated booklet.

Westinghouse Electric and Manufacturing Company, East Pittsburg, Pa.—A copy of pamphlet on high-speed motors in the woodworking industry.

G. and J. Weir, Limited, Monel Department, Cathcart, Glasgow.—A copy of Bulletin No. 103, discussing Monel metal as applied to textile machinery.

Manlove, Alliott and Co., Limited, Nottingham.—Card illustrating the G. W. Decoudun ironing machine; also Circular No. 557B, dealing with the same machine.

English Electric Company, Limited, Queen's House, Kingsway, W.C. 2.—Price list No. 2110 of ironclad oil break switch pillars, Classes SXA, SXB and SXC.

N. Taylor and Son, 17, Goree-Piazzas, Liverpool.—Folder discussing wrought iron case hardening and annealing boxes; also hydro-carbonated bone black for case hardening.

Edgar Allen and Co., Limited, Imperial Steel Works, Sheffield.—An illustrated pamphlet which describes the plant and machinery used in the production of portland cement.

Ransomes and Rapier, Limited, 32, Victoria-street, S.W. 1.—A copy of the electric capstans catalogue for docks, yards, sidings, factories, foundries, collieries and warehouses.

Wadkin and Co., North Evington, Leicester.—A new folder describing and illustrating the latest combined surfacing and thicknessing machines manufactured by the company.

Power Gas Economy Company (T. M. Hunter, Proprietor), 50, Wellington-street, Glasgow.—Illustrated leaflet on the Hunter gas burners for firing boilers, stoves and furnaces.

Joseph Stubbs, Limited, Manchester.—Pocket catalogue of special textile machinery for winding, doubling, clearing, gassing, reeling, preparing, polishing, and bundling yarns.

Lacy-Hulbert and Co., Limited, Boreas Works, Beddington, Croydon.—A copy of a pamphlet on complete compressor unit for steel construction, road and concrete breaking, &c.

The Parsons Motor Company, Limited, Town Quay Works, Southampton.—An illustrated supplementary list of the firm's 1923 4½in. series of marine and stationary oil and petrol engines.

"Eternit" Pietra Artificiale, Soc. Anon., Norfolk House, E.C. 4.—Pamphlet on "Italit" pipes for water mains; also leaflet on "Italit" corrugated asbestos cement sheets and ridges.

M. W. Woods, 146, Bishopsgate, E.C. 2.—Leaflets on "M.W." rectifiers, A.D. and D.C. economical battery charging, the "M.W." ceiling fans, and the "M.W." exhaust fans, alternating and direct current.

Westinghouse Electric and Manufacturing Company, East Pittsburg, Pa., and Baldwin Locomotive Works, Philadelphia, Pa.—A copy of new illustrated pamphlet treating of mine and industrial locomotives.

M. L. Metcalfe, 16, Bartholomew Villas, Kentish Town, N. 5.—Copy of an illustrated brochure describing plant and work carried out by the British Ropeway Engineering Company, Limited, 34, Fenchurch-street, E.C. 4.

National Boiler and General Insurance Company, Limited, Sales Dept., National Buildings, St. Mary's Parsonage, Manchester.—An illustrated list of tools and instruments for use in connection with steam and hot water boilers.

British Griffin Chilled Iron and Steel Company, Limited, Temple House, Tallis-street, E.C. 4.—Brochure No. 4A dealing with special "Kosmos" chilled castings for docks and harbours, including dredger tumblers, ladder rollers, &c.

Werkspoor, Amsterdam.—An illustrated descriptive list of Werkspoor marine Diesel engines. A brochure on the eleven years' operation of the first motor ship Vulcanus, and an illustrated list of vessels engined by Werkspoor and its licensees.

Henry Pooley and Son, Limited, John Bright-street, Birmingham.—A copy of a new catalogue on machinery for milling, sifting and blending tea, by Bartlett and Son, Limited, Birmingham, of which Messrs. Pooley are the sole manufacturers.

Ateliers de Constructions Electriques de Charleroi, 56, Victoria-street, S.W. 1.—Bulletin No. 96, issue October-December, 1922, containing articles treating of high-tension cables, electric driving of rolling mills and centrifugal pumps.

Forthcoming Engagements.

Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of its insertion, the necessary information should reach this office on, or before, the morning of the Wednesday of the week preceding the meetings. In all cases the time and place *at which the meeting is to be held should be clearly stated.*

TO-DAY.

British Electrical Development Association.—Caxton Hall, Victoria-street, S.W. 1. Paper, "The Electrical Industry, the Press, and the Public," by Mr. A. Gowans Whyte. 7.30 p.m.

Institute of Marine Engineers.—Hotel Victoria, S.W. Annual conversazione. 6.30 p.m.

Junior Institution of Engineers.—39, Victoria-street, S.W. 1. Lecturette, "Glass-forming Machines," by Mr. C. Saxton. 7.30 p.m.

Royal Institution of Great Britain.—Albemarle-street, Piccadilly, W. 1. Discourse, "The Water in the Atmosphere," by Dr. G. C. Simpson. 9 p.m.

SATURDAY, MARCH 3rd.

Institution of British Foundrymen: Lancashire Branch.—College of Technology, Manchester. Lecture, "Patternmaking, with special reference to Scroll Cutting," by Mr. H. Stead. 4 p.m.

Royal Institution of Great Britain.—Albemarle-street, Piccadilly, W. 1. "Atomic Projectiles and their Properties, III.," by Sir Ernest Rutherford. 3 p.m.

MONDAY, MARCH 5th.

Bradford Engineering Society.—The Technical College, Bradford. Lecture, "Recent Developments in Connection with Waste Heat Recovery for Steam-raising Purposes," by Major W. Gregson. 7.30 p.m.

Institute of Transport.—Institution of Electrical Engineers, Savoy-place, W.C. 2. Paper, "The Operation of a Railway-owned Port," by Major G. S. Szlumpper. 5.30 p.m.

Society of Engineers.—The Geological Society, Burlington House, Piccadilly, W. 1. Paper, "The Physical Properties of Clay and the Dynamics of Pile Driving," by Mr. A. S. E. Ackermann. 5.30 p.m.

TUESDAY, MARCH 6th.

Institution of Civil Engineers.—Great George-street, Westminster, S.W. 1. Papers: "Some Problems Connected with the Rivers and Canals in Southern India," by Mr. J. M. Lacey; "An Irrigation Project of the Californias," by Mr. S. L. Rothery; "The Influence of Silt on the Velocity of Water Flowing in Open Channels," by Mr. A. B. Buckley, jun. 6 p.m.

WEDNESDAY, MARCH 7th.

Institution of British Foundrymen: Burnley Section.—The Municipal College, Ormerod-road, Burnley. Paper, "Some Foundry Problems," by Mr. W. H. Meadowcroft. 7.15 p.m.

Institution of Electrical Engineers.—Savoy-place, Victoria Embankment, W.C. 2. Wireless Section meeting "Development of Naval High-power Valves," by Mr. H. Morris-Airey. 6 p.m.

Institution of Railway Signal Engineers.—Institution of Electrical Engineers, Savoy-place, Victoria Embankment, W.C. 2. Continued discussion on "Rotary Interlocking Block," by Mr. A. B. Wallis. 3 p.m.

Institution of Sanitary Engineers.—Caxton Hall, Westminster, S.W. 1. Paper, "The Mechanics of the Activated Sludge Process," by Mr. J. A. Coombs. 7.30 p.m.

WEDNESDAY and THURSDAY, MARCH 7th and 8th.

Institute of Metals.—Institution of Mechanical Engineers, Storey's-gate, S.W. 1. Annual general meeting, 10 a.m. to 5 p.m. on each day. Annual dinner, Trocadero Restaurant, Piccadilly-circus, W. 1, on Wednesday, 7th, 7 p.m. for 7.30 p.m. For programme see page 183.

THURSDAY, MARCH 8th.

Royal Institution of Great Britain.—Albemarle-street, Piccadilly, W. 1. "Water Power of the Empire" (II.), by Mr. T. Stevens. 3 p.m.

Scottish Engineers' Association.—Hall of the Royal Philosophical Society, Glasgow. "Dalmarnock Power Station," by Mr. R. B. Mitchell.

FRIDAY, MARCH 9th.

Ex-British-Westinghouse Association.—Holborn Restaurant, London, W.C. 1. Annual dinner.

Institute of Cost and Works Accountants.—Connaught Rooms, Great Queen-street, W.C. 2. Second annual costing conference.

Institution of Mechanical Engineers.—Storey's Gate, S.W. 1. Informal meeting. Discussion:—"Aerial Ropeways," opened by Mr. W. A. Bowden. 7 p.m.

Royal Institution of Great Britain.—Albemarle-street, Piccadilly, W. 1. Discourse, "Sunlight and Disease," by Dr. C. W. Saleeby. 9 p.m.

SATURDAY, MARCH 10th.

Royal Institution of Great Britain.—Albemarle-street, Piccadilly, W. 1. "Atomic Projectiles and their Properties" (IV.), by Sir Ernest Rutherford. 3 p.m.

TUESDAY, MARCH 13th.

Institute of Metals: Birmingham Local Section.—Chamber of Commerce, New-street, Birmingham. Paper, "Casting Temperature Conditions and the Properties of Phosphoric Bronze," by Mr. G. L. Bailey. 7 p.m.

Institute of Metals: North-East Coast Local Section.—Armstrong College, Newcastle-on-Tyne. Paper, "The Corrosion of Metals," by Dr. W. H. Hatfield. 7.30 p.m.

Institute of Metals: Scottish Local Section.—Institution of Engineers and Shipbuilders in Scotland, 39, Elmbank-crescent, Glasgow. Annual general meeting. Discussion, "Problems Awaiting Solution," opened by Professor J. H. Andrew. 7.30 p.m.

WEDNESDAY, MARCH 14th.

Institution of Automobile Engineers.—Institution of Mechanical Engineers, Storey's-gate, S.W. 1. Paper, "Multi-wheel and Track Motor Vehicles," by Major T. G. Tulloch. 7.45 p.m.

THURSDAY, MARCH 15th.

Institute of Metals: London Local Section.—Institute of Marine Engineers, 85–88, The Minories, E. 1. Discussion, "The Heat Treatment of Non-ferrous Metals," opened by Mr. W. B. Clarke. 8 p.m.

FRIDAY, MARCH 16th.

Institute of Metals: Swansea Local Section.—University College, Singleton Park, Swansea. Paper, "Gaseous Firing of Industrial Furnaces," by Dr. E. W. Smith. 7.15 p.m.

Institution of Mechanical Engineers.—Storey's Gate, Westminster. Report of Steam Nozzles Research Committee. 6 p.m.

TUESDAY, MARCH 20th.

Newcomen Society.—Prince Henry's Room, 17, Fleet-street, E.C. 4. Paper, "The Early History of the Gas Process," by Mr. D. Brownlie. 5.30 p.m.

FRIDAY, MARCH 23rd.

Institute of Metals: Sheffield Local Section.—Mappin Hall of the University, St. George's-square, Sheffield. Paper, "Further Notes on Britannia Metal," by Captain F. Orme. 7.30 p.m.